INSTALLATION RESTORATION PROGRAM

WILLIAMS AIR FORCE BASE, ARIZONA

FINAL
RECORD OF DECISION

OPERABLE UNIT 3 (OU-3)

CONTRACT NUMBER F41624-94-D-8047, ORDER D0007

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January 1996

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This Record of Decision (ROD) comprises a compliance document under the remedial investigation activities at Williams Air Force Base (WAFB), Arizona. The report documents the selected remedy for Operable Unit 3 (OU-3) at WAFB. The ROD is based on the remedial investigation (RI) and feasibility study (FS) reports for OU-3. The work is under the direction of IT Corporation (IT).

Nancy Troyer, AFMC Human Systems Center (PKVCC), is the contracting officer.

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List of Acronyms

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AFB	Air Force Base
ARAR	applicable or relevant and appropriate requirements
ATC	Air Training Command
AV	AeroVironment, Inc.
bgs	below ground surface
BTEX	benzene, toluene, ethyl benzene, and xylene
Btu	British Thermal Units
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	chemical of potential concern
CRDL	contract-required detection limit
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DP-13	Pesticide Burial Area
EE/CA	engineering evaluation/cost assessment
Energy Systems	Martin Marietta Energy Systems, Inc.
EPA	U.S. Environmental Protection Agency
ES	Engineering-Science
FFA	Federal Facilities Agreement
FT-02	Fire Protection Training Area No. 2
FSP	field sampling plan
FT-03	Fire Protection Training Area No. 1
GAF	gastrointestinal absorption factor
HAZWRAP	Hazardous Waste Remedial Actions Program
HBGL	health-based guidance levels
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HNUS	Halliburton NUS Corporation
HQ	hazard quotient
HSP	health and safety plan

List of Acronyms (Continued)

IEUBK	Integrated Exposure Uptake Biokinetic Model for Lead in Children
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IT	IT Corporation
JP-4	jet petroleum grade 4
kg	kilogram
LF-04	Landfill
MEK	methyl ethyl ketone
µg/dL	micrograms per deciliter
µg/L	micrograms per liter
mg/m^3	milligrams per cubic meter
mg/kg	milligrams per kilogram
msl	mean sea level
NCP	National Contingency Plan
O&M	operation and maintenance
OU	Operable Unit
OWS	oil/water separator
PAH	polyaromatic hydrocarbon
PRG	preliminary remediation goals
psig	pounds per square inch gage
QAPP	quality assurance project plan
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD/RA	remedial design/remedial action
RfD	reference doses
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	Record of Decision
RW-11	Radioactive Instrumentation Burial Area
RWCD	Roosevelt Water Control District
SARA	Superfund Amendment and Reauthorization Act
scfm	standard cubic feet per minute

List of Acronyms *(Continued)*

SD-09	Southwest Drainage System
SD-10	Northwest Drainage System
SF	slope factors
SS-01	Hazardous Materials Storage Area
ST-12	Liquid Fuels Storage Area
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TPH	total petroleum hydrocarbon
TRC	Technical Review Committee
TVH	total volatile hydrocarbon
USAF	United States Air Force
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compounds

1.0 Declaration

1.1 Site Name and Location

Williams Air Force Base (AFB) is located in Maricopa County, Mesa, Arizona (Figure 1-1). The Fire Protection Training Area No. 2 (FT-02) and the Southwest Drainage System (SD-09), shown on Figure 1-2 make up Operable Unit (OU)-3. The deep soils at the Liquid Fuels Storage Area (ST-12) were originally part of OU-3, but the remedy for ST-12 will be addressed in an amendment to the OU-2 Record of Decision (ROD).

1.2 Statement and Basis of Purpose

This ROD presents the selected remedial action for the sites that compose OU-3 at Williams AFB. The ROD was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendment and Reauthorization Act (SARA), and, to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record for this operable unit.

The U.S. Environmental Protection Agency (EPA) and the State of Arizona concur with the selected remedy for OU-3.

1.3 Assessment of the Site

Benzene, chloroform, and 1,4-dichlorobenzene are present in FT-02 soils at concentrations above cleanup levels. Existing conditions at the site have been determined to pose a total incremental lifetime cancer risk (ILCR) of 3.4×10^{-5} for future residential exposures and 2.0×10^{-5} for current occupational exposures to contaminated soils. The most significant exposure pathway is inhalation of fugitive dust. The organic contaminants represent a potential future threat to groundwater at the site due to their concentration and distribution within the soil. Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health and the environment.

1.4 Description of the Selected Remedy

As with many Superfund sites, the environmental problems at Williams AFB are complex. As a result, the U.S. Air Force (USAF) has organized the work into the following OUs.

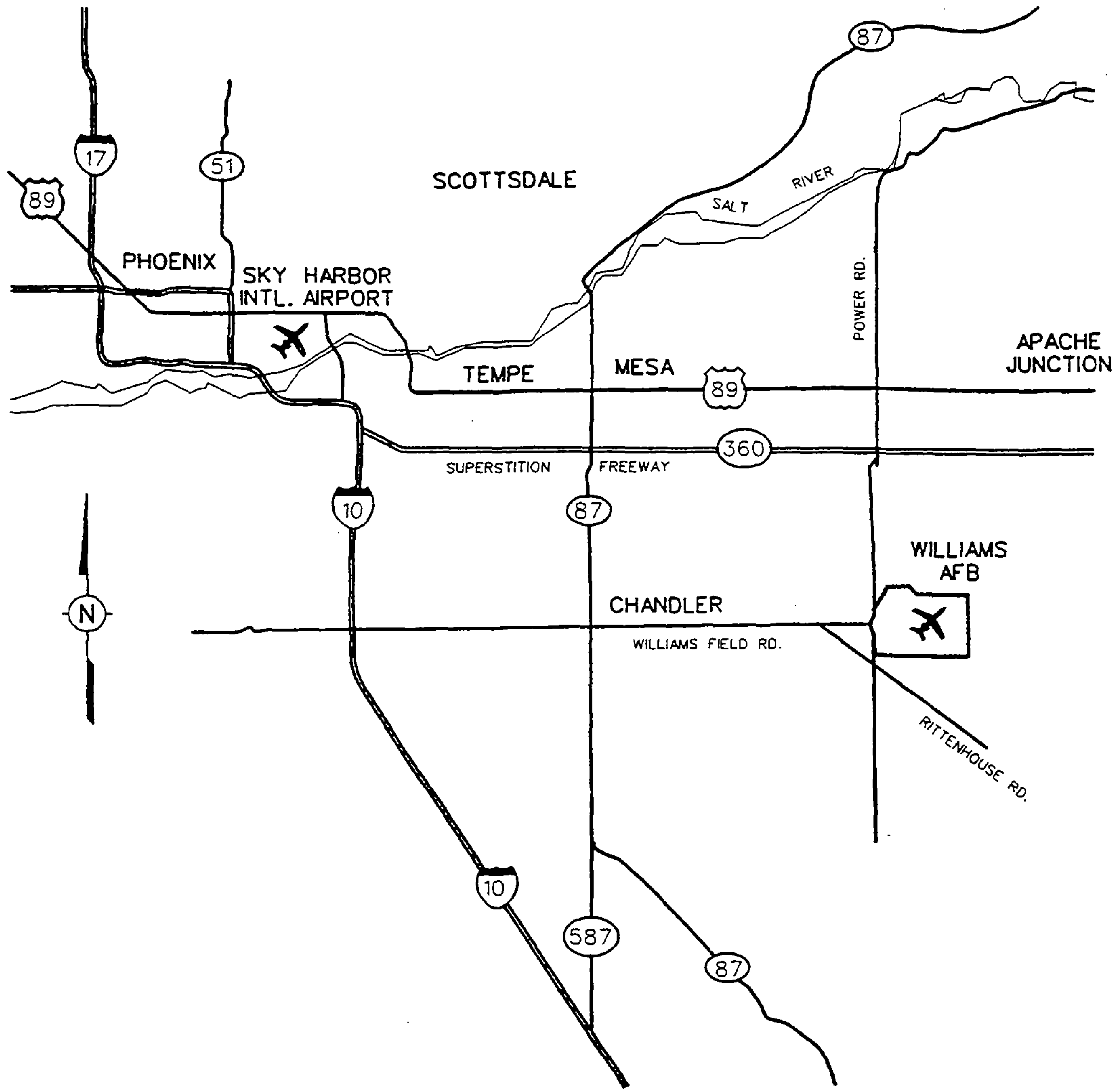

FIGURE 1-1
SITE LOCATION MAP

WILLIAMS AIR FORCE BASE
PHOENIX, ARIZONA

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 02/24/95 | DATE LAST REV.: | DRAFT. CHCK. BY: D.AGUILAR | INITIATOR: D.WILLEN | DWG. NO.409880ES.003
DRAWN BY: D.HIGGS | DRAWN BY: | ENGR. CHCK. BY: D.WILLEN | PROJ. MGR.: W.CARTER | PROJ. NO.:409881

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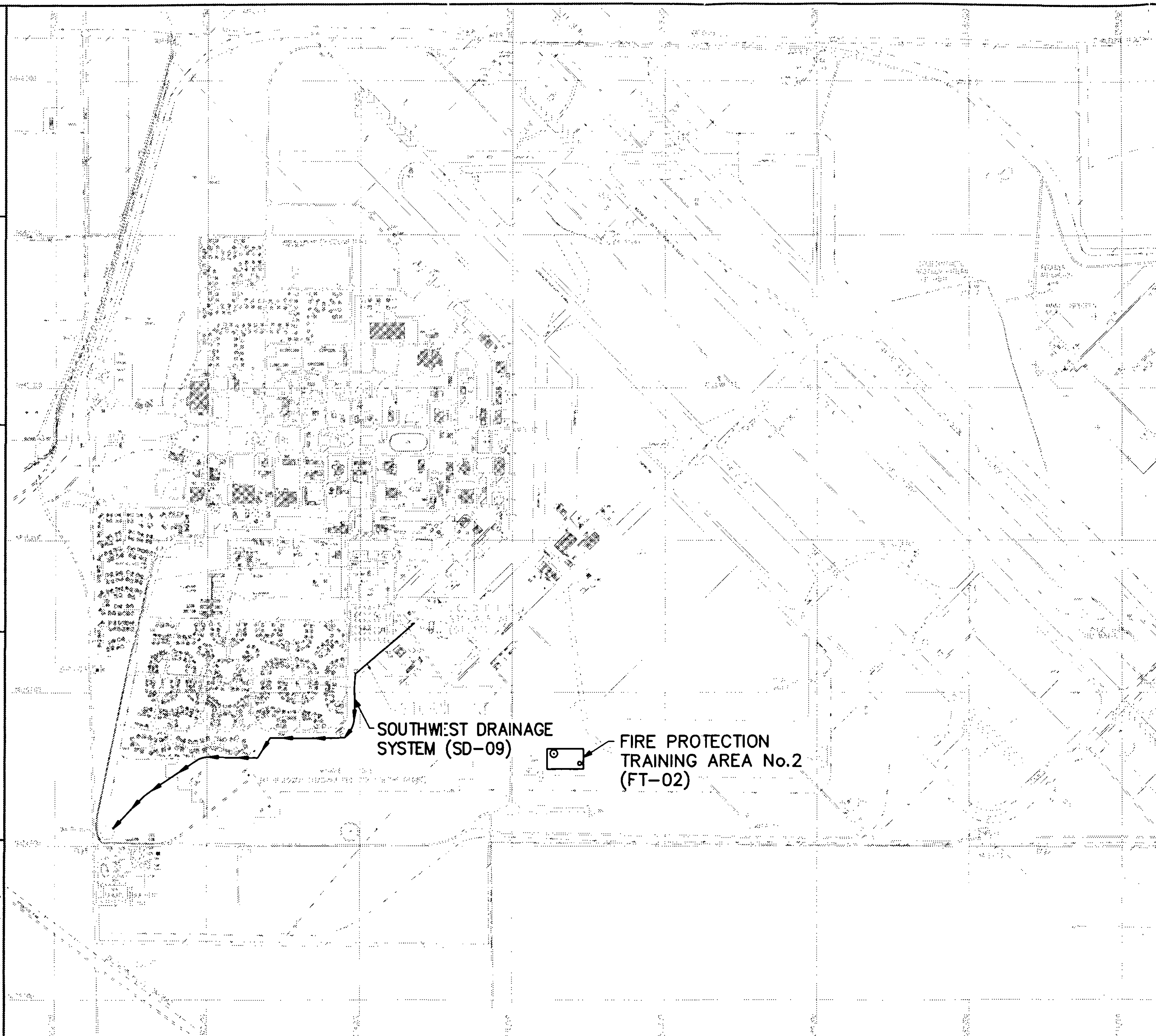


LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- RUNWAY/TAXIWAY/APRON
- RAILROAD
- FENCE
- BASE BOUNDARY
- HISTORICAL BOUNDARY
- WAFB-10 BENCHMARK
- ROAD TEXT
- PERMANENT BUILDING
- SEMI-PERMANENT BUILDING
- TEMPORARY BUILDING
- BUILDING NUMBER
- GRID LINE
- N832000 GRID COORDINATE
- POND
- BASE PRODUCTION MONITORING WELL

SCALE:
0 600 1200 FEET

FIGURE 1-2
BASE SITE MAP
WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 9/13/95	DATE LAST REV.:	INITIATOR: W. ANDERSON	DRAWING NO.: 409877-D-15
DRAWN BY: J. HUBBARD	DRAWN BY:	PROJECT MGR.: W. CARTER	PROJECT NO.: 409877

40987715 09/13/95 0:10pm jhubbard

- OU-1 addresses soil and groundwater contamination at the following ten sites:

  - Landfill (LF-04)
  - Fire Protection Training Area No. 1 (FT-03)
  - Northwest Drainage System (SD-10)
  - Radioactive Instrumentation Burial Area (RW-11)
  - Pesticide Burial Area (DP-13)
  - Hazardous Materials Storage Area (SS-01)
  - Underground storage tanks (UST) at four areas (ST-05, ST-06, ST-07, ST-08).

- OU-2 addresses soil to a depth of 25 feet and groundwater at the Liquid Fuels Storage Area (ST-12). Soil from a depth of 25 feet to groundwater will be added to OU-2 in a ROD amendment.

- OU-3 addresses soil and groundwater at the following two sites:

  - Fire Protection Training Area No. 2 (FT-02)
  - Southwest Drainage System (SD-09).

- OU-4 addresses investigations of contamination at 11 sites.

- OU-5 addresses removal actions at eight sites.

The USAF in conjunction with EPA and the State of Arizona have selected cleanup remedies for OU-1 and OU-2. The deep soils at ST-12 (unsaturated soils below 25 feet) will be addressed in a future amendment to the OU-2 ROD. Sites FT-02 and SD-09 are the subject of this ROD. Investigations or removal actions have not yet been initiated for OU-4 or OU-5 because the sites associated with these OUs were only recently identified as areas of potential contamination.

The description of the selected remedy for each of the OU-3 sites is presented in the following sections.

1.4.1 Fire Protection Training Area No. 2

The selected remedy for FT-02 involves in situ treatment of approximately 25,000 cubic yards of soil contaminated with benzene, chloroform, and 1,4-dichlorobenzene at concentrations above risk-based cleanup levels. A bioventing treatment system will be constructed to inject air into the subsurface soils, thereby stimulating the biodegradation of these organic contaminants to nontoxic compounds by indigenous soil microorganisms. The bioventing system is comprised of an aboveground blower system and a series of air injection wells placed in the contaminated soils. The bioventing system will remain in operation until the concentrations of benzene, chloroform, and 1,4-dichlorobenzene are reduced to cleanup levels.

A bioventing treatability system was installed and initial respiration tests were conducted in August 1995. This gave indications of the destruction rate. A second round of respiration tests began in January 1996.

1.4.2 Southwest Drainage System

No further action is recommended.

1.5 Statutory Determinations - Fire Protection Training Area No. 2

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy uses permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Because this remedy will reduce the concentration of chemicals of concern (COC) to cleanup levels that permit unrestricted use of and unlimited exposure to the site, a 5-year review will not be required unless the remedial action is not fully complete within 5 years of its initiation.

1.6 Declaration Statement - Southwest Drainage System

Previous remedial actions at SD-09 have lowered the health risks associated with exposure to contaminated soil at the site to an acceptable level as calculated under a residential exposure scenario. Therefore, no further remedial action is required for SD-09 soil. Because the limited residual soil contamination is distributed within the top few feet of soil, there is no evidence of any future threat to groundwater. Therefore, no remedial action is required for groundwater at the site. Because the residual soil contamination at SD-09 is within health protective levels that permit unrestricted use of and unlimited exposure to the site, a 5-year review will not be required for SD-09.

This Record of Decision for Operable Unit Number Three at Williams Air Force Base, Arizona may be executed and delivered in any number of counterparts, each of which when executed and delivered shall be deemed to be an original, but such counterparts shall together constitute one and the same document.

Alan K. Olsen, Director
U.S. Air Force, Base Conversion Agency

May 15, '96
Date

Julie Anderson, Director
Federal Facilities Cleanup Office
U.S. Environmental Protection Agency, Region IX

June 8, 1996
Date

Russell F. Rhoades, Director
Arizona Department of Environmental Quality

June 26, 96
Date

Rita Pearson, Director
Arizona Department of Water Resources

July 16, 1996
Date

2.0 Decision Summary

2.1 Site Name, Location, and Description

Williams AFB was a flight training base located in Maricopa County, Arizona approximately 30 miles southeast of Phoenix and just east of Chandler (Figure 1-1). The Base, commissioned as a flight training school, was constructed on 4,127 acres of government land in 1941. Runway and airfield operations, industrial areas, housing, and recreational facilities are located on the Base. Training activities started after construction, with jet aircraft training beginning in 1949. The Base was closed September 30, 1993.

This ROD addresses remedial actions for OU-3, which is comprised of FT-02 and SD-09.

Williams AFB is relatively isolated from any large metropolitan area. It is surrounded primarily by agricultural land in a valley that has had a long history of intensive agricultural use, predominantly for crops of citrus, cotton, and alfalfa. Smaller urban areas such as Mesa, Chandler, Gilbert, and Apache Junction are located 5 to 15 miles northeast and northwest of the Base. The Queen Creek and Chandler Heights areas are approximately 5 miles south and west of the Base boundary, respectively. Table 2-1 lists these towns and others with distance and direction from Williams AFB; the population of the towns are included. These areas are separated from the Base by cultivated and uncultivated land.

During its active status, 3,029 military personnel and 869 civilian employees were stationed at the Base. Many of the military personnel lived off Base in one of the surrounding areas. The total population actually living on Base, including dependents, was approximately 2,700. On an average workday, the population of the Base increased to more than 5,000 because of the influx of both civilian employees and military personnel living off base (Cost Branch Controller Division, 1987).

A development plan for the region (Sunregion Associates, 1987), if implemented, will dramatically alter the region surrounding Williams AFB. The portions of the development plan of most importance to the Base are the East Mesa Subarea Plan and the Queen Creek-Chandler Heights Plan. The former proposes development for portions of the City of Mesa, the Town of Gilbert, the City of Apache Junction, and the land area north of Williams AFB. The proposed land area for the Queen Creek-Chandler Heights Plan is east of Chandler, just south of the Base in the approximate location of the Town of Queen Creek. The plan is to

Table 2-1

Cities Surrounding Williams Air Force Base

City	Direction Relative to Williams AFB	Distance from Williams AFB (miles)	Population[a]
Apache Junction	North-Northeast	10	18,100
Chandler	West	5	90,533
Gilbert	Northwest	5	29,188
Mesa	North-Northwest	15	288,091
Queen Creek	South	5	2,667
Tempe	Northwest	20	141,865
Phoenix	Northwest	25	893,983

[a]April 1, 1990 Census, Public Law Tape 94-171.

develop the proposed area residentially and commercially for a 25-year period. If implemented, this development will dramatically impact the demographics and population around the Base. The closure of Williams AFB could also impact the region.

There are no major surface water bodies within a 10-mile radius of the Base. The Base lies between the 100-year and 500-year flood level for streams in the Gila River Basin (U.S. Department of Housing and Urban Development, 1979). Storm drainage on the Base is directed to a combination of open channels used to drain most of the Base and underground drainage structures. Storm drainage from the Base flows either to the Roosevelt Water Control District (RWCD) floodway that flows southward in the vicinity of the Base or directly to the floodway west of the Base, or into the wastewater treatment plant.

There are at least 90 domestic permitted wells within a 3-mile radius of the Base. These wells are not affected by the contamination at OU-3. The Base currently performs periodic monitoring and sampling of groundwater wells on the Base in the vicinity of LF-04 and ST-12.

The climate of Williams AFB is similar to that of Phoenix and the rest of the Salt River Valley. The temperature ranges from very hot in the summer to mild in winter. Rain comes mostly in two seasons: from late November until early April, and in July and August. Average annual precipitation is approximately 7.1 inches. Humidity ranges from approximately 30 percent in winter to 10 percent in summer. Williams AFB is also characterized by light winds. The mean annual pan evaporation is approximately 100 inches and the annual lake evaporation for the area is approximately 72 inches (National Oceanic and Atmospheric Administration [NOAA], 1977).

Williams AFB lies in the eastern portion of the Basin and Range Physiographic Lowlands Province of south-central Arizona, which is located in the Salt River Valley. The local topography is controlled by large-scale normal faulting that has resulted in the formation of broad, flat, alluvial-filled valleys separated by steep isolated hills and mountain ranges. Arizona Department of Water Resource's hydrologic maps show the Base bounded to the north by the Usery Mountains, to the east by the Superstition Mountains, to the south by the Santan Mountains, and to the west by South Mountain.

The topography of the Base slopes gently to the west with a generally less than 1 percent grade. Elevations range from 1,326 feet above mean sea level (msl) on the west side of the Base to 1,390 feet above msl at the southeast corner of the Base.

According to Laney and Hahn (1986), the area of the Base is underlain by six geologic units: crystalline rocks, extrusive rocks, red unit, lower unit, middle unit, and upper unit. The crystalline and extrusive rocks compose the surrounding mountains and the basement complex underlying the consolidated and unconsolidated sediments of the valley. The four units overlying the basement complex are of sedimentary origin and have the surrounding mountains and local drainage as their source areas.

The red unit immediately overlies the basement complex and is composed of well-cemented breccia, conglomerate, sandstone, and siltstone of continental origin with interbedded extrusive flow rocks. The lower unit overlies the red unit and consists of playa, alluvial fan, and fluvial deposits with evaporites and interbedded basaltic flows present in lower sections (Laney and Hahn, 1986). The middle unit overlies the lower unit and is composed of playa, alluvial fan, and fluvial deposits with no associated evaporites. The middle unit received its sediment primarily from the Salt River, whereas the red and lower units had the local mountains as the principal source. The youngest unit in the stratigraphic sequence is referred to as the upper unit. This unit consists of channel, floodplain, terrace, and alluvial fan deposits of largely unconsolidated gravel, sand, silt, and clay.

Geologic conditions beneath OU-3 have been characterized by fixed-interval soil sampling and/or using a combination of continuous coring and geophysics. The deposits encountered during drilling at OU-3 are correlative to the upper unit of Laney and Hahn (1986) and possibly to the extreme upper section of their middle unit.

There are two major soil associations found in the vicinity of Williams AFB. The Mohall-Contine Association is found over much of the Base, and the Gillman-Estrella-Avondale Association is found at the southern boundary of the Base. The Mohall-Contine and the Gillman-Estrella-Avondale Associations have generally the same characteristics, being well drained and nearly level with slopes of less than 1 percent.

An extensive unsaturated (vadose) zone has been produced in the vicinity of Williams AFB over the last 50 years by a declining water table caused by irrigation and water supply withdrawals. However, due to decreased agricultural activity from urbanization and an increased water supply derived from surface sources, groundwater extraction has been reduced. Groundwater elevations at Williams AFB have been increasing over the last 3 to 4 years at a rate ranging from 2 to 4 feet per year.

Low yearly rainfalls and high evapotranspiration rate of the area reduce the potential for recharge to occur through the vadose zone at the Base. However, several wet years over the last decade have likely contributed to the rise of groundwater levels.

Groundwater beneath OU-3 sites is currently encountered at depths ranging from 200 to 235 feet below ground surface. IT Corporation (IT) and other contractors have placed monitoring wells at two of the OU-3 sites (ST-12 and FT-02) to monitor groundwater quality in two zones of the aquifer. At both sites, the aquifer comprises two zones, referred to as the upper and lower portions of the aquifer. Groundwater beneath ST-12 is not a part of OU-3 and therefore, will not be discussed here. Information regarding this can be found in the OU-2 Report (IT, 1992).

Recent groundwater elevation data (from 1993 to February 1995) indicate that groundwater flows generally to the northeast at FT-02. This is consistent with previous report flow directions, even though groundwater elevations have been observed to have risen approximately 10 feet over the last 5 years. Seasonal groundwater fluctuations can range from 5 to 8 feet between summer and winter months. At FT-02, recent hydraulic gradients range from 0.0023 to 0.0060. Because no site-specific aquifer tests have been conducted in these wells, the hydraulic conductivity data from ST-12 is used to represent hydrogeologic properties below FT-02. Using the hydraulic conductivity data from ST-12 and assuming an effective porosity value of 0.30, the groundwater flow velocity is found to range between 0.05 and 0.2 feet per day.

Groundwater at SD-09 has not been investigated and no monitoring wells have been installed at this site. However, the Landfill (in OU-1) is immediately south of SD-09 and groundwater beneath the Landfill (LF-04) is presumably representative of groundwater beneath SD-09. At LF-04, groundwater is currently measured between 180 to 205 feet below ground surface and flows from west to east across the site.

2.2 Site History and Enforcement Activities

Williams AFB was a flight training base that opened in 1942. It was immediately commissioned as a flight training school, and training activities with jet aircraft began in 1949.

Throughout its history, pilot training was the primary activity at Williams AFB. At various times, bombardier, bomber pilot, instrument bombing specialist, and fighter gunnery training schools were also housed on Base. Over the years, a wide variety and large number of aircraft have been housed at Williams AFB.

The Installation Restoration Program (IRP) was implemented by the U.S. Department of Defense (DOD) in 1980 to identify and control environmental contamination from past hazardous materials use and disposal activities at USAF installations. The IRP is DOD's equivalent of the national Superfund program. SARA, passed by Congress in 1986, required cleanup of federal facilities to meet Superfund requirements.

IRP guidance was received at Williams AFB in July 1983 and the initial assessment study (designated as Phase I) was completed by Engineering-Science (ES) in 1984. Based on a review of available records pertaining to chemical handling and disposal practices, interviews with site personnel, and a site survey of activities at Williams AFB, the study identified the following nine potential sites where hazardous materials have been handled or disposed:

- Landfill
- Fire Protection Training Area No. 1
- Fire Protection Training Area No. 2
- Northwest Drainage System
- Southwest Drainage System
- Radioactive Instrumentation Burial Area
- Pesticide Burial Area
- Hazardous Materials Storage Area
- Liquid Fuels Storage Area.

A second investigation (designated as Phase II) was conducted by AeroVironment, Inc. (AV) from September 1984 to December 1985. This investigation was initiated to confirm the information in the ES report and to verify the presence and quantify the extent of contamination. In 1987, AV completed an additional investigation (Phase II, Stage 2) to define the most likely pathways for contaminant migration from each site and to confirm the presence or absence of contamination along those pathways. Some of the analytical data utilized in this ROD were collected during this Phase II, Stage 2 investigation.

In 1987, as a result of AV investigations, IT, under a contract with Martin Marietta Energy Systems, Inc. (Energy Systems) through the Hazardous Waste Remedial Actions Program (HAZWRAP) (IT, 1987a), performed a simple remedial action. This activity involved designing soil cementing and a concrete cap for approximately 350 feet of the uppermost portion of SD-02. Plans and specifications were issued in September 1987 (IT, 1987b) and the work was completed that year.

In October 1988, the Air Training Command (ATC) contracted Energy Systems and its subcontractor, IT, through the U.S. Department of Energy (DOE) to complete the remedial investigation/feasibility study (RI/FS), proposed plan, and ROD at Williams AFB. As part of these efforts, a work plan and quality assurance project plan (QAPP) (IT, 1991a), which includes a health and safety plan (HSP), and a field sampling plan (FSP) (IT, 1991b) were issued. The continuation of the RI was initiated in January 1989. The sites investigated include the nine original sites plus four UST sites. The complete list of all Williams AFB sites then consisted of the following:

- Landfill (LF-04)
- Fire Protection Training Area No. 1 (FT-03)
- Fire Protection Training Area No. 2 (FT-02)
- Northwest Drainage System (SD-10)
- Southwest Drainage System (SD-09)
- Radioactive Instrumentation Burial Area (RW-11)
- Pesticide Burial Area (DP-13)
- Hazardous Materials Storage Area (SS-01)
- Liquid Fuels Storage Area (ST-12)
- USTs at four areas (ST-05, ST-06, ST-07, ST-08).

Williams AFB was added to the NPL on November 21, 1989. The NPL primarily serves as an information tool for EPA to identify sites that possibly warrant further investigation and remedial action.

As a consequence of inclusion on the NPL listing, negotiations were completed and a Federal Facilities Agreement (FFA) was signed on September 21, 1990. The FFA establishes a cooperative and participatory framework among the federal and state agency members, defines their roles and responsibilities, and develops a process to resolve any disputes that may arise during the study and execution phases of the IRP. In addition, the FFA prioritizes and schedules the investigation and remedial actions at Williams AFB through the designation of OUs that aid in managing these activities. Parties to the FFA include the USAF, the EPA, the Arizona Department of Environmental Quality (ADEQ), and the Arizona Department of Water Resources (ADWR).

A ROD for OU-2 was signed in December 1992. The selected remedy for site ST-12 involves a combination of soil vapor extraction with bioenhancement to remediate affected soils to a depth of 25 feet, and groundwater extraction and treatment via air stripping with emission abatement to address the contaminated groundwater. The selected remedy will be implemented until the COCs (that present an unacceptable risk to human health or the environment in soil (benzene, 1,4-dichlorobenzene) and groundwater (benzene, naphthalene, toluene) are reduced to concentrations below cleanup levels.

A ROD for OU-1 was signed in June 1994. The selected remedy for OU-1 involved installing a permeable cap over the landfill to limit human exposure to dieldrin and beryllium contaminated surface soils and control natural erosion processes. The remedy also included measures to restrict access to the site such as warning signs and perimeter fencing, as well as land-use restrictions to protect the integrity of the landfill cover and the operation of the groundwater monitoring system.

History of past waste practices, environmental investigations, enforcement activities, and remedial actions for each OU-3 site is presented in the following sections.

2.2.1 Fire Protection Training Area No. 2

2.2.1.1 Site Description and History

FT-02 is located on approximately 8.5 acres near the southern boundary of the Base (Figure 1-2). FT-02 was used for fire protection training exercises between 1958 and 1991. Waste solvents, hydraulic fluids, oils, and fuel were burned at the area from 1958 until approximately 1968. Since 1968, jet petroleum grade 4 (JP-4) has been used for training exercises. Until the mid-1970s, two to three fires were ignited per week. In more recent years, 8 to 12 fire training exercises per quarter have been typical (ES, 1984).

During the 1950s and 1960s, up to 1,000 gallons of flammable material was used per training exercise. The volume of combustible material decreased to approximately 600 gallons per event in the 1970s, and then to 300 gallons per exercise from the 1980s until 1991, when facility use stopped. Extinguishing agents, used until the early 1970s, include protein foam and chlorobromomethane. In more recent years, aqueous film-forming foam, halon, and dry chemicals have been used (ES, 1984).

The area initially used for training consisted of shallow pits on the ground where the flammable material was placed for burning. Water was applied to the soil before each burn to minimize the total impact of the waste application by hydrophobic repulsion. However, not all flammable materials were burned during the fire training exercises. The remaining material either volatilized or soaked into the ground (ES, 1984).

In 1983, the area was expanded from a single pit to two burn pits, a large pit and a small pit. The pits were reconstructed to include a concrete liner, and the large pit was equipped with a drain connected to a collection tank (ES, 1984).

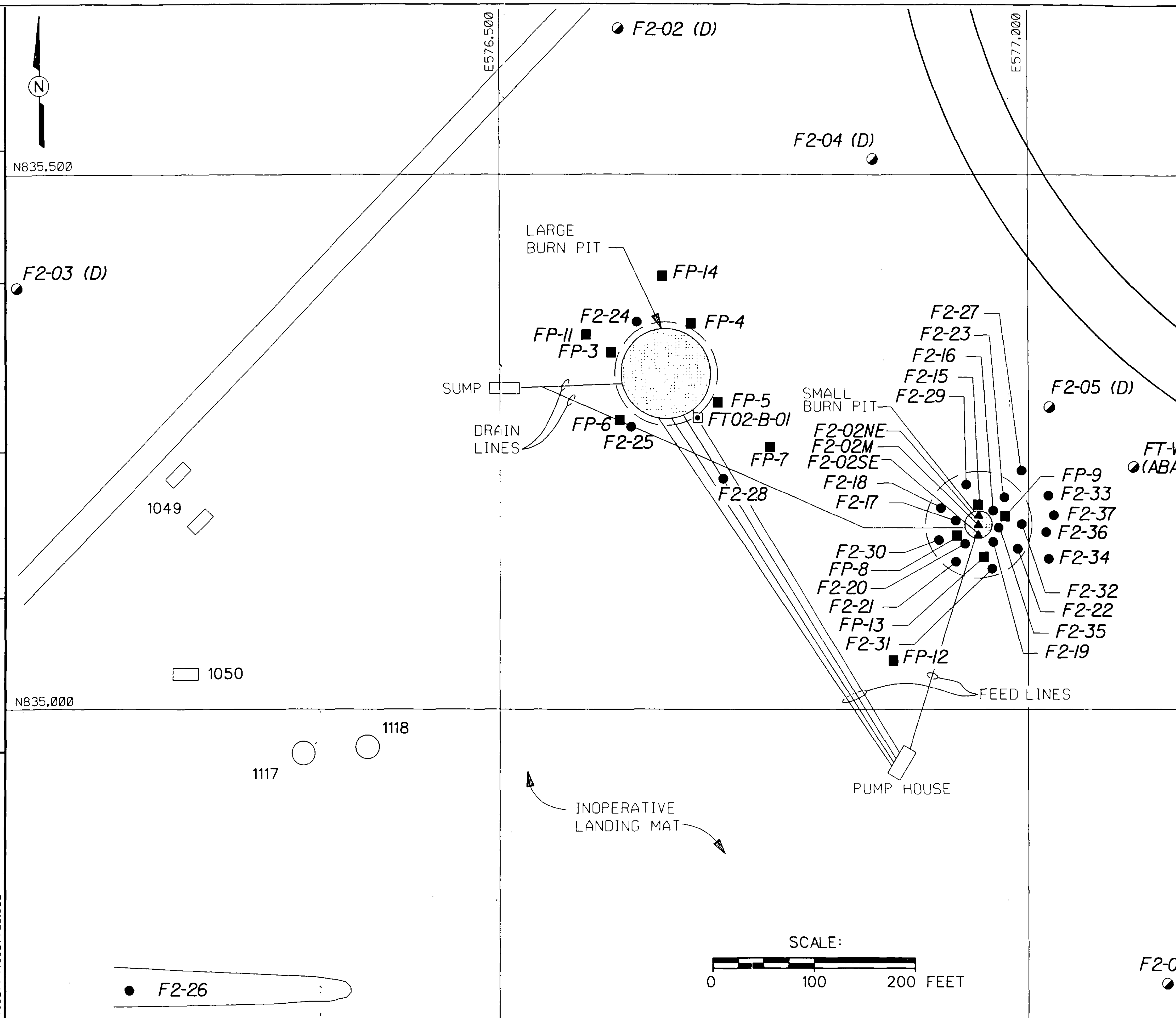
Normally, water and the extinguishing agent used during training exercises filled the liner. Material that flowed over the liner or that was blown over by wind either volatilized or percolated into the ground.

2.2.1.2 Investigations

The Phase I document identified FT-02 as an area at Williams AFB where past activities may have resulted in contamination (ES, 1984). During the Phase II, Stage 1 investigation (AV, 1986), 15 shallow soil borings were installed to a maximum depth of 25 feet (Figure 2-1). An additional 22 borings were drilled to a maximum depth of 210 feet during Stage 2 work (AV, 1987). Including geotechnical samples, AV collected 114 soil samples for analyses; of these, 110 were analyzed for contaminant constituents.

AV installed and collected water samples from five groundwater monitoring wells at FT-02 during the Stage 2 activities (Figure 2-1).

As part of the ongoing RI, IT continued to sample the monitoring wells at FT-02 installed by AV. Well FT-WS-06 was installed in 1989 to a depth of 225 feet to determine if two aquifers were present at FT-02. This well was subsequently abandoned in 1991 because it was dry. Also, IT collected soil samples from a boring that was installed at a 45-degree angle underneath the large burn pit. The angle boring measured 110 feet along its length and the bottom of the borehole was approximately 78 feet deep (vertical). This boring was started at the edge of the large burn pit and drilled so that samples could be collected from below the concrete liner to determine if contamination existed prior to liner installation. Figure 2-1 presents the locations of borings and wells installed at FT-02.



NOTES:

1. STAGE 1 BOREHOLES 1, 2 & 10 NOT SHOWN.
2. LOCATIONS OF FORMER FEED AND DRAIN LINES AND SUMP ARE APPROXIMATE.

LEGEND:

- MONITORING WELL
- (S) SHALLOW MONITORING WELL
- (D) DEEP MONITORING WELL
- ANGLED SOIL BORING
- STAGE 1 SOIL BORING
- STAGE 2 SOIL BORING
- 1050 FACILITY AND NUMBER
- SURFACE SOIL SAMPLE (1994)

FIGURE 2-1

FIRE PROTECTION TRAINING AREA NO. 2 (FT-02) MONITORING WELL AND BOREHOLE LOCATIONS WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 05/15/95 | DATE LAST REV.: | DRAFT. CHCK. BY: D.AGUILAR | INITIATOR: W.H.ANDERSON | DWG. NO.: 409877ES.038

DRAWN BY: D.AGUILAR | DRAWN BY: | ENGR. CHCK. BY: W.H.ANDERSON | PROJ. MGR.: W.CARTER | PROJ. NO.: 409877

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A sediment sample was collected in 1991 to further characterize the site. This sample was collected from the sump that received fluids from both burn pits at FT-02, and was then analyzed for dioxins and furans. Three surface soil samples were collected from FT-02 in August 1994 and analyzed for polyaromatic hydrocarbon (PAH).

2.2.1.3 Other Actions

An engineering evaluation/cost assessment (EE/CA) for FT-02 was prepared in 1992 to evaluate remedial alternatives (IT, 1993a). The first phase of the remedial action recommended by this EE/CA was performed by Halliburton NUS Corporation (HNUS) from February through April 1994. Phase I consisted of removal of the two fire pits, associated structures, piping at FT-02, and incidental soil. The following activities were performed as part of the removal action:

- Removal and disposal of more than 5,000 gallons of fluid from the two fire pits and associated piping
- Excavation, removal, and disposal of two concrete fire pits and gravel fill material; one concrete sump; one steel fuel/water separator; pump house and slab; and associated steel, concrete, and asbestos piping
- Removal and transport of two steel aboveground storage tanks formerly containing JP-4 and water for off-site destruction and disposal
- Backfilling of excavations with clean fill material and restoration of surfaces to their original condition.

Additional details concerning the removal of the FT-02 structures may be found in the site activity report (HNUS, 1994). Current plans call for the initiation of bioventing treatability studies at FT-02 in the latter part of 1995.

2.2.2 Southwest Drainage System

2.2.2.1 Site Description and History

SD-09 consists of the old and the existing southwest drainage ditch. This system has been present since the Base was constructed in 1941 (AV, 1986). The old portion of SD-09, now filled in, originated east of 5th Street and ran west-northwest through an area that was the location of Base housing (Figure 2-2). Aerial photographs show that sometime between 1948 and 1954 the existing portion of this drainage ditch was constructed (IT, 1990).

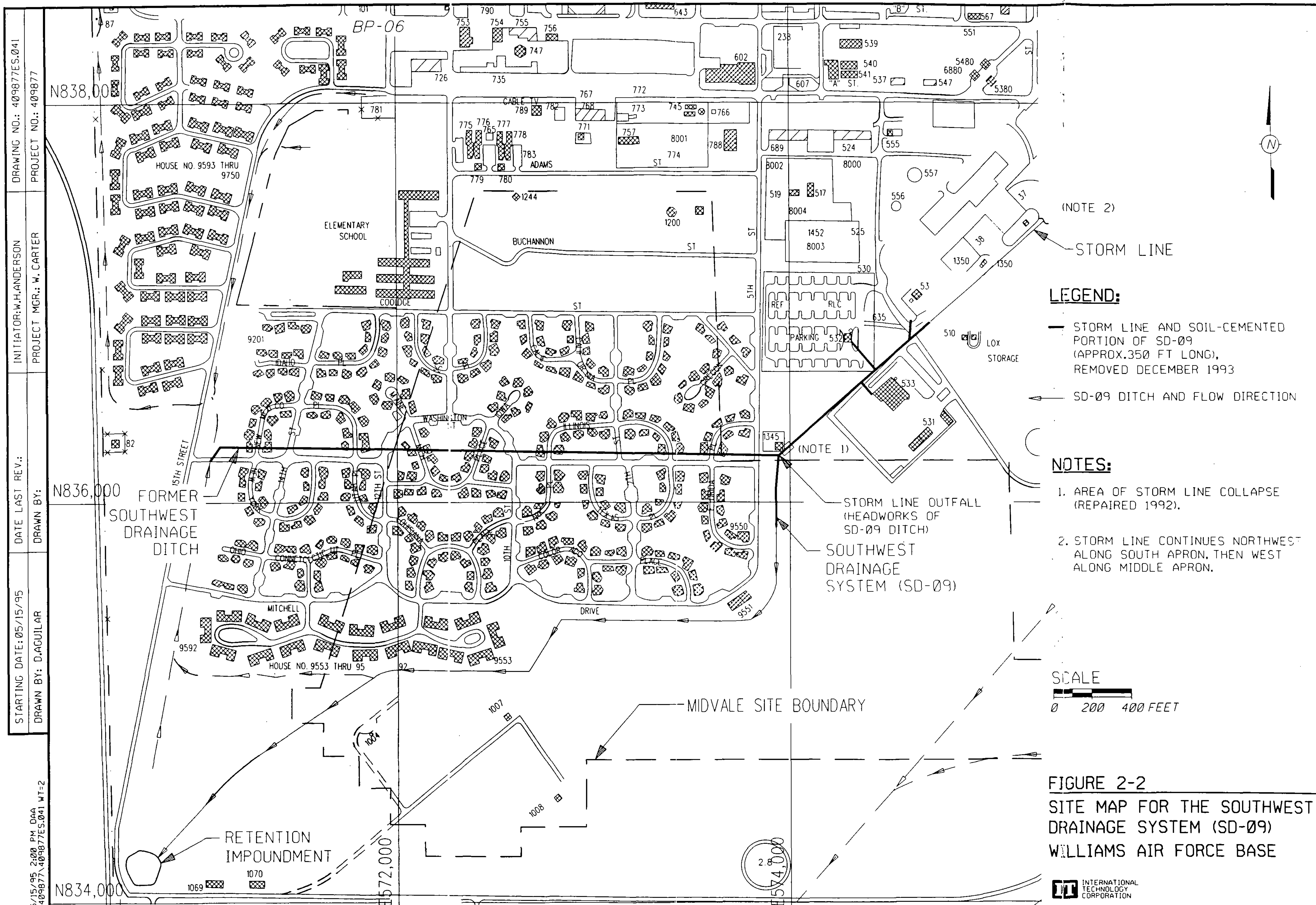


FIGURE 2-2
SITE MAP FOR THE SOUTHWEST DRAINAGE SYSTEM (SD-09)
WILLIAMS AIR FORCE BASE

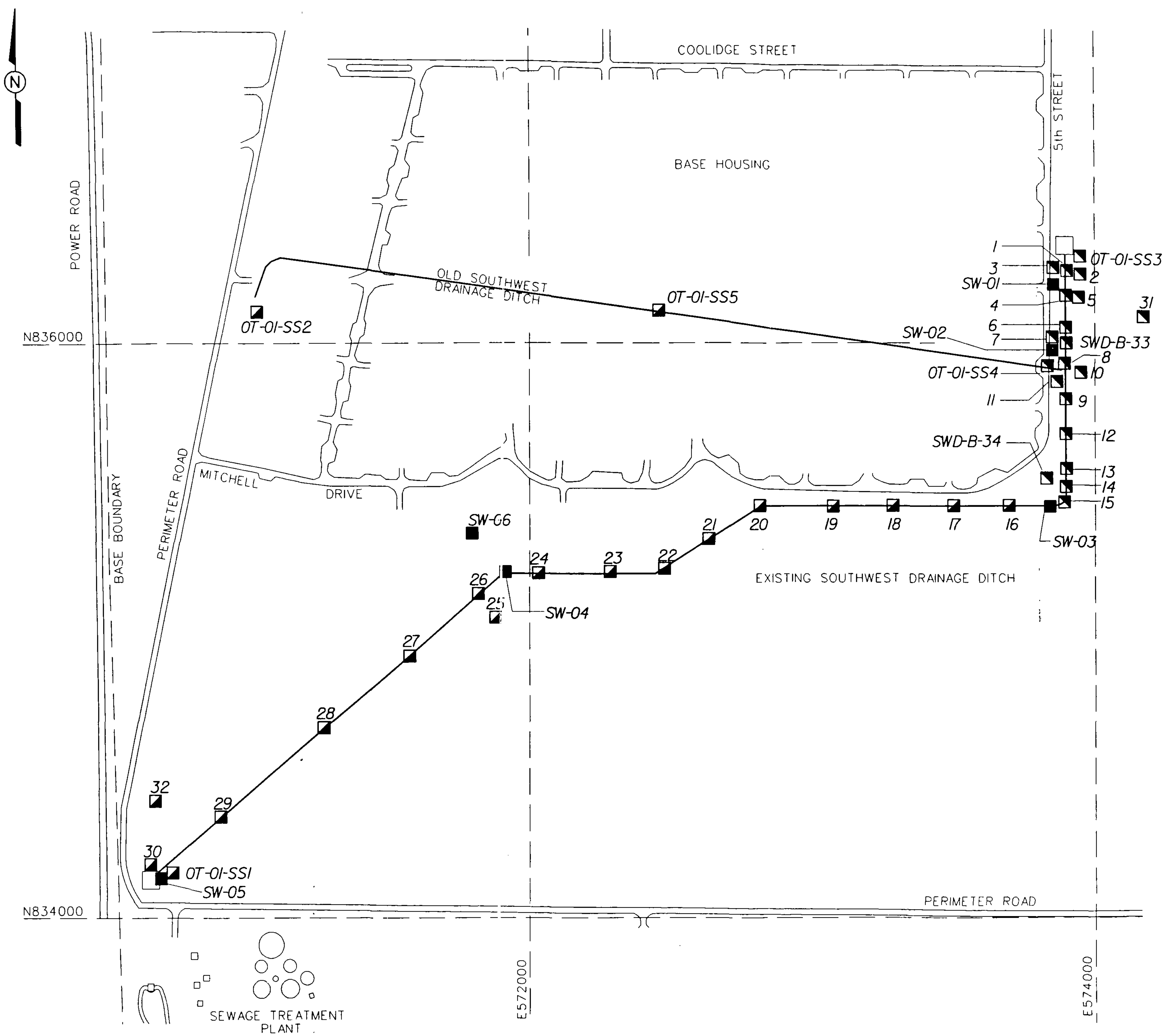
SD-09 runs for approximately 4,000 feet along the southern edge of the Base housing. The drainage ditch is a shallow V-shaped channel. The top width spans approximately 15 to 20 feet and the depth ranges from approximately 1 to 5 feet. Approximately 85 percent of this open channel lies within 100 feet of Base housing.

Because the storm sewer system was connected to SD-09, the system has received rinse water from the plating shop, aircraft washing wastes, and spills from miscellaneous aircraft and vehicle maintenance operations. These materials include, but are not limited to fuel, hydraulic fluid, solvents, oils, paints, and thinners. Drainage from the Hazardous Materials Storage Area (SS-01) near Building 1080 may have released hazardous substances to SD-09, and these substances could have traveled through a perforated drainage pipe that led south-west from SS-01, then northwest, connecting to SD-09.

Investigations. The Phase I document identified SD-09 as an area at Williams AFB where past hazardous material handling and disposal practices may have resulted in contamination (ES, 1984). During the Phase II, Stage 1 investigation, AV installed six shallow soil borings (SW-01 through SW-06) to a maximum depth of 40 feet (Figure 2-3) and collected and analyzed 12 soil samples (AV, 1986).

In 1987, IT installed 32 shallow boreholes approximately 2 to 3 feet deep from which 32 soil samples were collected and analyzed. Also, an additional 28 surface soil samples were collected and analyzed. In 1989, IT installed 5 shallow boreholes (OT-01-SS-01 through OT-01-SS-05) from which 15 subsurface soil samples and another 5 surface soil samples were collected. The boring logs for these samples are presented in Appendix A of the OU-3 RI report (IT, 1994). Among these samples, two were taken along the perforated drainage pipe that led to SD-09 from SS-01. Two additional soil borings were installed in September 1991 (SWD-B-33 and SWD-B-34) to a depth of approximately 40 feet to more fully characterize SD-09. Eight samples from these borings were analyzed. This addition brought the total borings installed by IT during the OU-1 RI to 7 and samples analyzed to 23. Locations for these borings are shown on Figure 2-3.

A total of 45 locations have been sampled during past investigations (through 1992) of the SD-09. The locations shown in Figure 2-3 were sampled during several different sampling events beginning with the Phase II, Stage 1 soil borings in 1984 (AV, 1986).



LEGEND:

IT SOIL BORING LOCATION (APPROXIMATE) AND NUMBER

AV SOIL BORING LOCATION (APPROXIMATE) AND NUMBER

NOTES:

1. NUMBER 1 THROUGH NUMBER 32 REPRESENT BORING NUMBERS BH-01 THROUGH BH-32.
2. BORINGS NUMBERS OT-01-SSX REPRESENTS SAMPLE NUMBERS SS-0X-MD* (APPENDIX G) WHERE "X" IS A NUMBER 1 THROUGH 5 AND "*" REPRESENTS THE DEPTH OF THE SAMPLE COLLECTED.

SCALE

0 400 800 FEET

FIGURE 2-3

SOUTHWEST DRAINAGE SYSTEM (SD-09) SOIL BORING LOCATIONS FOR BOREHOLES INSTALLED PRIOR TO 1993
WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 05/15/95 | DATE LAST REV.: | DRAFT. CHCK. BY: D.AGUILAR | INITIATOR: W.H.ANDERSON | DWG. NO.: 409877ES.039

DRAWN BY: D.AGUILAR | DRAWN BY: | ENGR. CHCK. BY: W.H.ANDERSON | PROJ. MGR.: W.CARTER | PROJ. NO.: 409877

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Seven surface soil samples (H2353 through H2359) were collected (Figure 2-4) to fill data gaps at various points along SD-09, including the retention impoundment in accordance with the approved work plan and FSP addendums for OU-3 (IT, 1993b,c).

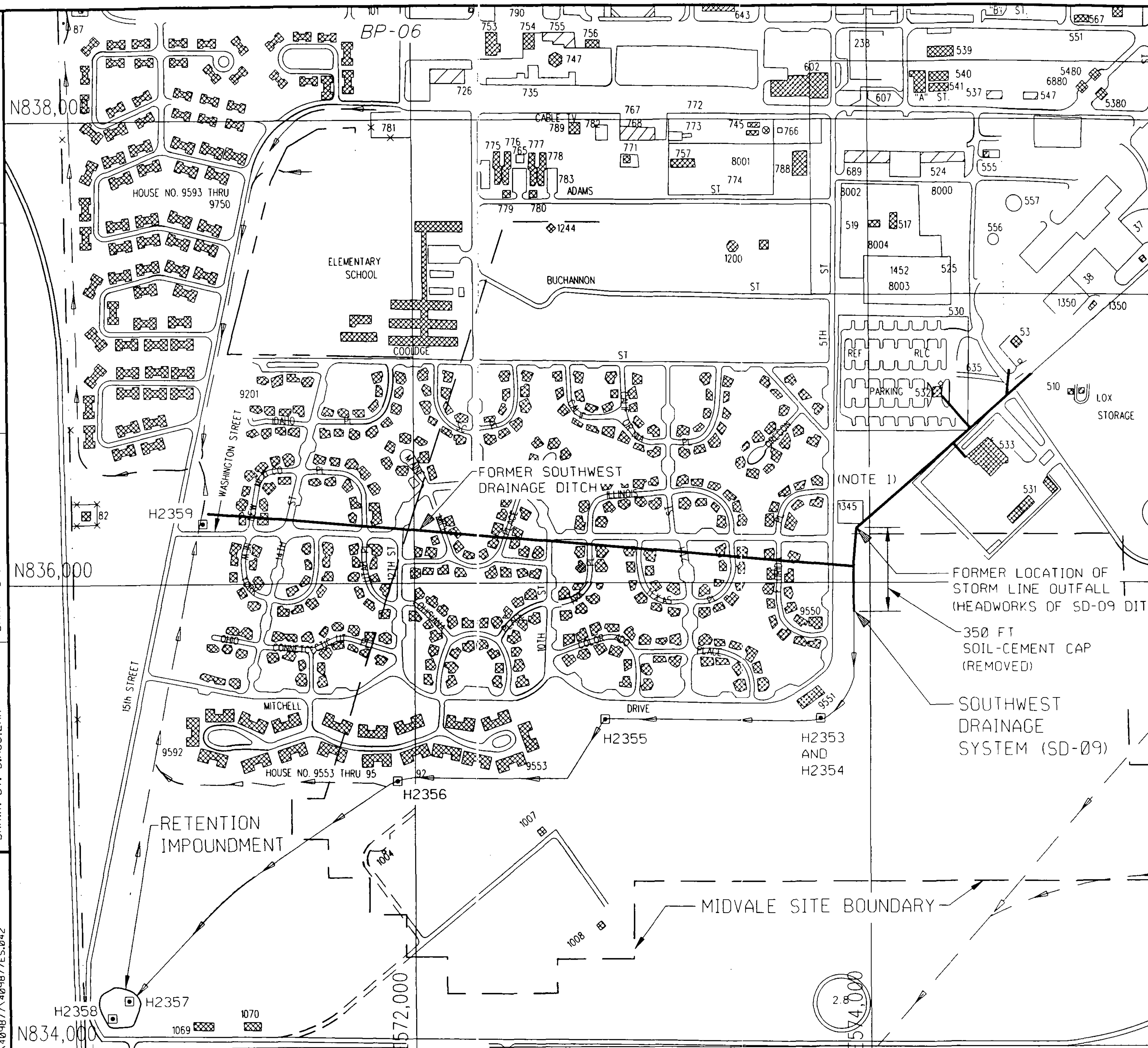
2.2.2.2 Other Actions

During Phase II, Stage 1, AV recommended that the soils from a 50-foot length of the channel be excavated to a depth of 2 feet and removed (AV, 1986). A simple removal action was performed on SD-09 to remediate a portion of the existing ditch. This removal action was completed in 1988 and resulted in the upper 350 feet of the drainage channel being soil cemented and covered with a 4-inch concrete cap.

In 1992, there was a collapse in the storm line upstream of the SD-09 drainage system headworks (Figure 2-2). Approximately 65 feet of the line was replaced. Due to the presence of volatile organic compounds (VOC) in the pipe that collapsed, it was determined that the storm line beginning at Building 53 needed to be investigated. Based on agreement of the parties to the FFA, the storm line and four oil/water separators (OWS) and associated piping were added to SD-09 and this site was included in OU-3.

Work performed as part of the OU-3 RI at SD-09 was conducted from November 1993 through January 1994. Field investigation activities included the excavation, removal, and disposal of the storm line, four OWSs and associated piping, and the capped portion of SD-09 so that samples could be collected from underlying soil. All excavations were backfilled with clean material. Surface soil samples, along with samples collected from the bottom of the excavations, were taken for analyses. In addition, composite soil samples and sludge/pipe samples were collected for the purpose of waste characterization.

The OWSs and associated piping that led to the storm line were excavated and removed for disposal. Fourteen soil samples were collected from the sides and the bottoms of the excavations for confirmation that the source of contamination had been removed. Four additional soil samples were collected along the OWSs discharge pipe trenches. An additional 2 feet of soil was excavated at these sampling points prior to collecting a undisturbed sample for analyses. Additional composite soil samples were collected from the stockpiled soil (H2407), and a sample was collected of the pipe contents for characterization of the material for disposal. Some of the associated piping contained a sludge-like material with a slight hydrocarbon odor. Composite samples of the sludge were also collected for analyses (H2406 and Building 532 OWS-1 [ATI 312537-1]). Analyses performed for waste profile



LEGEND:

H2353 ▣ SURFACE SOIL SAMPLE (6-12 IN. BELOW CENTERLINE OF SD-09 DITCH) AND SAMPLE ID NUMBER.

— STORM LINE, OWS PIPING AND CEMENTED PORTION OF SD-09 (REMOVED) SAMPLED DECEMBER 1993

NOTES:

1. SEE FIGURE 1-13 FOR LOCATION OF SAMPLES COLLECTED UNDERNEATH REMOVED SOIL-CEMENTED CAP, STORM LINES, AND OWS PIPING
2. STORM LINE CONTINUES NORTHWEST ALONG SOUTH APRON, THEN WEST ALONG MIDDLE APRON.

SCALE

0 200 400 FEET

FIGURE 2-4

SAMPLE LOCATION MAP SOUTHWEST DRAINAGE SYSTEM (SD-09) WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWING NO.: 409877ES.042 | PROJECT NO.: 409877 | INITIATOR: W.H. ANDERSON | PROJECT MGR.: W. CARTER | DATE LAST REV.: | DRAWN BY: | STARTING DATE: 05/15/95 | DRAWN BY: D. AGUILAR

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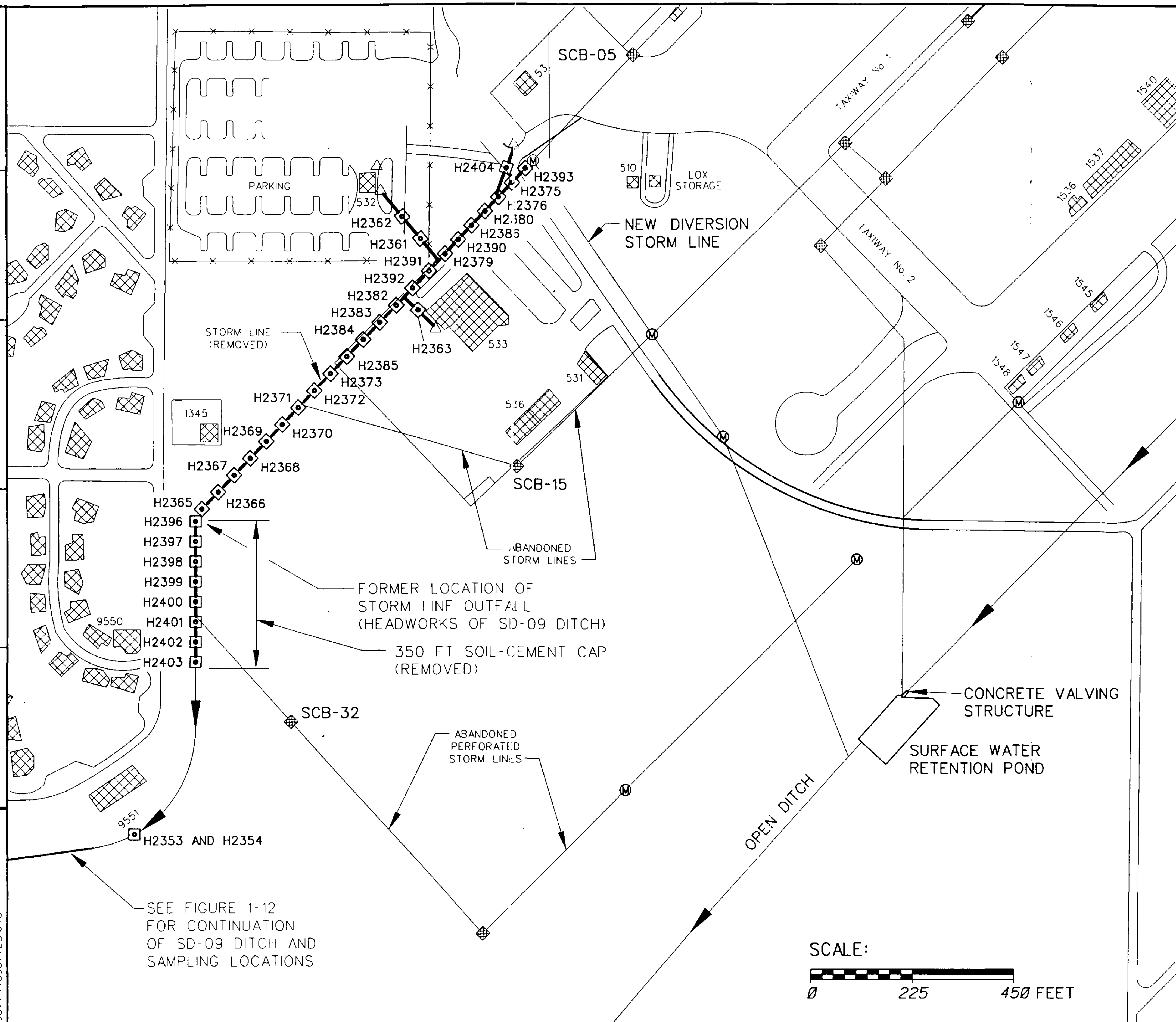
consisted of analyses for ignitability, paint filter test (Method 9095), petroleum hydrocarbons (Method 418.1), reactivity, Resource Conservation and Recovery Act (RCRA) metals by Toxicity Characteristic Leaching Procedure (TCLP) (Method 1311), chlorinated hydrocarbons (Method 8010), and aromatic hydrocarbons (Method 8020) analyses. Pipe containing any sludge-like material was placed in a roll-off bin, crushed, and disposed of as a hazardous waste at the licensed landfill owned by Laidlaw Environmental Services in Buttonwillow, California. The soil and incidental concrete and pipe were disposed of at the Butterfield Station Facility in Mobile, Arizona.

During excavation of the storm line, the soil was stockpiled on plastic along the sides of the excavation in accordance with the approved work plan addendum. Initially, the soil was excavated to the top of the pipeline so that the clean soil could be separated from the possibly contaminated soil. Then, the pipeline was removed and an additional 2 feet of soil were excavated and stockpiled. The soil was examined for evidence of contamination and field screening measurements with an HNu. In addition, 22 soil samples were collected from the bottom of the excavation (at an approximate 5.5- to 6.5-foot depth) at approximately 50-foot intervals (Figure 2-5). Later, composite samples (H2408, H2409, and H2410) were collected from the stockpiled soil for waste characterization. Samples were collected in accordance with the approved work plan and FSP addendums for OU-3 (IT, 1993b,c). Results from the stockpiled soil indicated that the excavated soil was contaminated but nonhazardous. Consequently, the soil was transported to the Butterfield Station Facility in Mobile, Arizona for disposal as a special waste.

The concrete cap and approximately 1 foot of soil underneath it were excavated, along 350 feet of SD-09 during December 8 through 14, 1993. The concrete cap had been installed as part of the remedial action that occurred in 1987. Eight surface soil samples (H2396 through H 2403) were then collected at approximately 50-foot intervals along the excavated 350-foot section of the drainage ditch and analyzed in accordance with the approved work plan and FSP addendums for OU-3 (IT, 1993b,c). Sample locations are shown on Figure 2-5. The excavated material was segregated and stockpiled for characterization for disposal. Composite samples were collected from the stockpiled soil (H2411) and concrete (SD-09 concrete [ATI 312537-02]) to determine the waste profile for disposal. The excavation was backfilled using clean material and the excavated material hauled off site for disposal. The excavated soil and concrete were hauled to the Butterfield Station Facility in Mobile, Arizona for disposal as a special waste.



N

LEGEND:

- H2365 — SOIL SAMPLE LOCATION & SAMPLE ID NUMBER.
- STORM SEWER MANHOLE (SMH-XX)
- OIL/WATER SEPARATOR REMOVED SEPTEMBER, 1993
- EXISTING STORM SEWER (REMAINING IN SERVICE)
- STORM SEWER ABANDONED AFTER REMOVAL OF SOIL-CEMENTED CAP AND CONNECTING STORM LINE IN DECEMBER 1993
- CEMENTED PORTION OF SD-09 (REMOVED) SAMPLED (SOIL) DECEMBER 1993
- STORM LINE & OWS PIPING (REMOVED) SAMPLED (SOIL) DECEMBER 1993
- STORM SEWER CATCH BASIN (SCB-XX)
- 532 BUILDING AND NUMBER

NOTES:

1. SOIL SAMPLES COLLECTED AT APPROXIMATELY 50 FOOT INTERVALS ALONG AND BENEATH STORM LINE, OWS PIPING AND SD-09 CONCRETE LINED DITCH AFTER REMOVAL OF PIPE AND CONCRETE.
2. A TOTAL OF EIGHT SOIL SAMPLES NOT SHOWN WERE COLLECTED FROM BENEATH THE OIL/WATER SEPARATORS AFTER REMOVAL.
3. LOCATIONS OF BUILDINGS, ROADS, UTILITIES ETC., AND SAMPLE LOCATIONS ARE APPROXIMATE.

FIGURE 2-5
1993 SAMPLE LOCATION MAP
SOUTHWEST DRAINAGE SYSTEM (SD-09)
WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

DWG NO.: 409877ES.040 | PROJ NO.: 409877
INITIATOR: W.H.ANDERSON | PROJ MGR.: W. CARTER
DRAFT. CHCK. BY: D.AGUILAR | ENGR. CHCK. BY: W.H.ANDERSON
DATE LAST REV.: | DRAWN BY:
STARTING DATE: 05/15/95 | DRAWN BY: D.AGUILAR

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A total of 49 soil samples were collected from SD-09, the storm line, the OWS, and associated piping excavations between September 29, 1993 and December 10, 1993 to better define the nature and extent of contamination. In addition, six composite samples were collected from the stockpiled soil for waste profiling prior to off-site disposal.

Eight soil samples were collected from the OWS excavations at Buildings 53, 532, and 533, and four soil samples from underneath the removed associated discharge piping. Twenty-two soil samples were collected from underneath the removed storm drain pipe between the headworks at the SD-09 ditch and a location approximately 17 feet southwest of the new manhole associated with the new diversion storm drain, south of Building 53. Eight surface soil samples were collected from under the 350-foot-long concrete cap at SD-09 after excavation of the concrete and approximately 1 foot of soil. An additional seven surface soil samples were collected from the SD-09 ditch and surface impoundment.

Soils from the excavations were stockpiled and composite soil samples were collected to establish a waste profile prior to off-site disposal. A pipe leading from the OWS at Buildings 53 and 532 to the storm line contained a material resembling sludge. This sludge material had a hydrocarbon odor; however, no significant concentrations of contaminants were detected with the HNu. Composite samples of the sludge were also collected for analyses to identify a waste profile. Composite samples were analyzed by Analytical Technologies, Inc. and Laidlaw Environmental Services.

A total of eight composite samples, including two sludge samples from the OWS piping and a concrete sample, were collected by IT and analyzed by Analytical Technologies, Inc. An additional two composite sludge samples from the OWS piping and a concrete sample were collected by IT for analyses by Laidlaw Environmental Services for establishing the waste profile. Analytical results for the waste profile samples are presented in Appendix G of the OU-3 RI report (IT, 1994).

The excavated soils and concrete were ultimately disposed of off site as a special waste at the Butterfield Station Facility in Mobile, Arizona. The sludge and associated piping were disposed of as a hazardous waste at Laidlaw Environmental Services in Buttonwillow, California.

2.3 Highlights of Community Participation

Ongoing Public Involvement. A community relations plan for the Base was issued in February 1991 (IT, 1991c) and updated in March 1995. This plan listed contacts and interested parties throughout the USAF, government, and the local community. The plan also established communication channels to ensure timely dissemination of pertinent information to the surrounding community through mailings, public announcements in the local newspaper, public meetings, public comment periods, public service announcements, and the establishment of information repositories in local libraries.

Early in the IRP, the Base established a Technical Review Committee (TRC) to provide review and offer comment and recommendations on the progress of the cleanup effort. The TRC included representatives from the USAF and other governmental agencies as well as appointed representatives from the surrounding communities. Governmental agencies represented included EPA Region IX, the ADEQ, ADWR, and the Maricopa County Department of Health.

With the advent of Base closure, the TRC was expanded to include additional community stakeholders and is now called the Restoration Advisory Board (RAB). Much the same as a TRC, the RAB acts as a forum for discussion and exchange of information regarding cleanup between the installation, governmental agencies and the community. However, because the RAB provides for an expanded and more diverse membership representing the community, a greater opportunity is afforded to those directly affected by the cleanup process to participate and provide input. This input will be especially valuable as decisions are made regarding transfer and end uses of Base property.

An Administrative Record that contains the documents relating to investigation and cleanup activities proposed for the Base has been established and is available for public inspection as part of the information repositories at the Gilbert Public Library, Gilbert, Arizona and the Base Conversion Agency (Williams AFB), Mesa, Arizona.

Public Involvement Specific To OU-3. The removal action at site FT-02 (one of three sites in OU-3) was described in an EE/CA released to the public in February, 1993. Concurrently, these documents were made available to the public in the Administrative Record. The notice of their availability was published in the *Arizona Republic/Phoenix*

Gazette on February 17, 1993, an action which coincided with the beginning of the 30-day public comment period.

The USAF has met the community relations requirements of CERCLA Sections 113 and 117 in the remedy selection process for OU-3 through the following activities. The OU-3 RI/FS was released for public review on June 26, 1995. This release was followed by an announcement in the *Arizona Republic/Phoenix Gazette* of the issuance of an OU-3 proposed plan for public comment and a public meeting. The 30-day public comment period on the proposed plan began June 26, 1995 and a public meeting was held July 18, 1995 in the City of Mesa, Arizona to discuss the proposed remedial alternatives. A fact sheet describing the proposed plan was distributed at the public meeting, placed in the information repositories, and to other interested individuals upon request. All written and oral comments received during the public comment period and the corresponding USAF responses are included in the Responsiveness Summary (Chapter 11.0).

3.0 Scope and Role of Operable Unit

As with many Superfund sites, the problems at Williams AFB are complex. As a result, the USAF has organized the work into five operable units. These are described in Section 1.4.

OU-1 includes the contaminated soils and groundwater at ten sites. Of the ten sites within OU-1, only the Landfill (LF-04) presents an unacceptable risk to human health and the environment. Surface soils at LF-04 are contaminated with beryllium and the pesticide dieldrin at concentrations above cleanup levels. The selected remedy for LF-04 involves the installation of a permeable cap over the site to limit human exposure to dieldrin and beryllium contaminated surface soils and control natural erosion processes. The remedy also includes measures to restrict access to the site, such as warning signs and perimeter fencing, as well as land-use restrictions to protect the integrity of the LF-04 cover and the operation of the groundwater monitoring system.

The principal risks to human health and the environment at OU-2 result primarily from contamination of soil and groundwater by JP-4 and its constituents (e.g., benzene, toluene), although other organic compounds have also been detected at the site. The ROD for OU-2 was signed in December 1992. The selected remedy involves a combination of soil vapor extraction with bioenhancement to remediate affected soils to a depth of 25 feet, and groundwater extraction and treatment via air stripping with emission abatement to address the contaminated groundwater. The remedial design/remedial action phase for OU-2 was conducted with a pilot study/demonstration study on the treatment of contaminated groundwater and a pilot study on the treatment of contaminated soils.

OU-3, addressed by this ROD, includes the contaminated soil at two sites, FT-02 and SD-09. Of these two sites, only FT-02 requires remedial action to reduce the concentration of benzene, chloroform, and 1,4-dichlorobenzene to cleanup levels. The principal threat at the site is the potential migration of soil contaminants to groundwater.

Investigations at OU-4 and removal actions at OU-5 have been completed, and reports are being prepared to document the work activities performed at these sites.

4.0 Summary of Site Characteristics

Chapter 4.0 provides an overview of the assessments conducted during the RI to characterize each site within OU-3. This summary presents the following information:

- Quantity, types and concentrations of hazardous substances
- Estimated volume of contaminants
- Lateral and vertical extent of contamination
- Mobility of identified contaminants
- Potential surface and subsurface pathways of contaminant migration.

Related information concerning site characteristics include suspected source areas at each site (Sections 2.2.1 through 2.2.2) and risk evaluations, contaminant carcinogenicity and potential routes of human and environmental exposures (Chapter 5.0).

Background concentrations have been developed for both soil and groundwater. For each matrix, regional ranges and Base-specific ranges have been compiled for inorganic species. Regional background ranges for soil and groundwater were developed from U.S. Geological Survey (USGS) data. For groundwater, data was obtained from wells within a 10-mile radius of the Base. For regional soil, USGS data for surficial soils were compiled from Maricopa and adjacent counties. Table 4-1 provides the regional background ranges for inorganic species for soil and groundwater.

Base-specific background concentration ranges for inorganics have been developed throughout the course of the RI. Background soil ranges were obtained from surface soil samples collected across the extent of the Base. Background groundwater ranges were compiled from site-specific background monitoring wells at certain sites on Base. Only more recent sampling data from background wells have been used to determine the Base-specific ranges for inorganics. Base-specific background ranges are shown in Table 4-1. Additional information concerning the development of the various background ranges for soil and groundwater is available in the OU-3 RI report (IT, 1994).

4.1 Fire Protection Training Area No. 2

Soils. The boundaries of the large and small burn pits (site source areas) are defined and the waste disposal practices are documented in Section 2.2.1. Soil samples were obtained primarily from within and adjacent to the pits (Figure 2-1).

Table 4-1

Background Inorganic Species Concentrations in Soil and Groundwater Williams Air Force Base

Constituent	Groundwater (µg/L)		Soil (mg/kg)	
	Base-Specific Range[a]	Regional Range[b]	Base-Specific Range[c]	Regional Range[d]
Antimony	ND[e]	-[f]	ND (<12)	< 1
Arsenic	ND	1 to 44	2.3 to 4.3	2 to 97
Barium	NA[g]	7 to 150	NA	-
Beryllium	ND	<0.5 to 0.7	1.0 to 1.6	1.0 to 1.5
Cadmium	ND	<1.0	ND (<1)	0.01 to 2.0[h]
Chromium	5.2 to 724[i]	-	16.9 to 24.8	15 to 100
Cobalt	NA	<3 to 3	NA	-
Copper	ND	<10 to 30	ND (<5)	15 to 200
Lead	ND	<10 to 14	10.4 to 19.4	10 to 100
Mercury	ND	-	ND (<0.2)	0.01 to 0.5[h]
Nickel	40 to 2160[i]	-	15.6 to 24.7	7 to 50
Selenium	ND to 2.1[j]	1 to 3	0.21 to 0.24	0.1 to 5[h]
Silver	ND	-	ND (<2)	0.01 to 8[h]
Thallium	ND	-	ND (<2)	0.1 to 0.8[h]
Zinc	ND to 13.3[j]	<3 to 38	ND (<4)	25 to 150

[a]Wells used to establish a Base-specific range: SS01-W-10, SS01-W-17, SS01-W-26, SS01-W-27, LF01-W-12 (September 1993 sampling).
[b]Data obtained from U.S. Geological Survey WATSTORE Database using wells located within 10 miles of Williams AFB.
[c]The average soil concentration represents the mean of nine surface soil samples plus one duplicate collected at Williams AFB in September 1993. The range presents the low and high values for the ten samples.
[d]Data obtained from surficial soils in Gila, Maricopa, Pima, Pinal, and Yuma counties.
[e] ND = not detected.
[f]- = not available .
[g]NA = not analyzed because this chemical is not a priority pollutant metal. Base-specific background samples were analyzed for priority pollutant metals in accordance with the approved work plan.
[h] Data obtained from B. J. Alloway, 1990.
[i]Wells used to establish a Base-specific range: SS01-W-10, SS01-W-17, SS01-W-26, SS01-W-27, LF01-W-12 (September 1993, December 1993, and March/April 1994 sampling). Range represents detected concentrations.
[j]Analyte concentration is between instrument detection limit (IDL) and contract-required detection limit (CRDL).

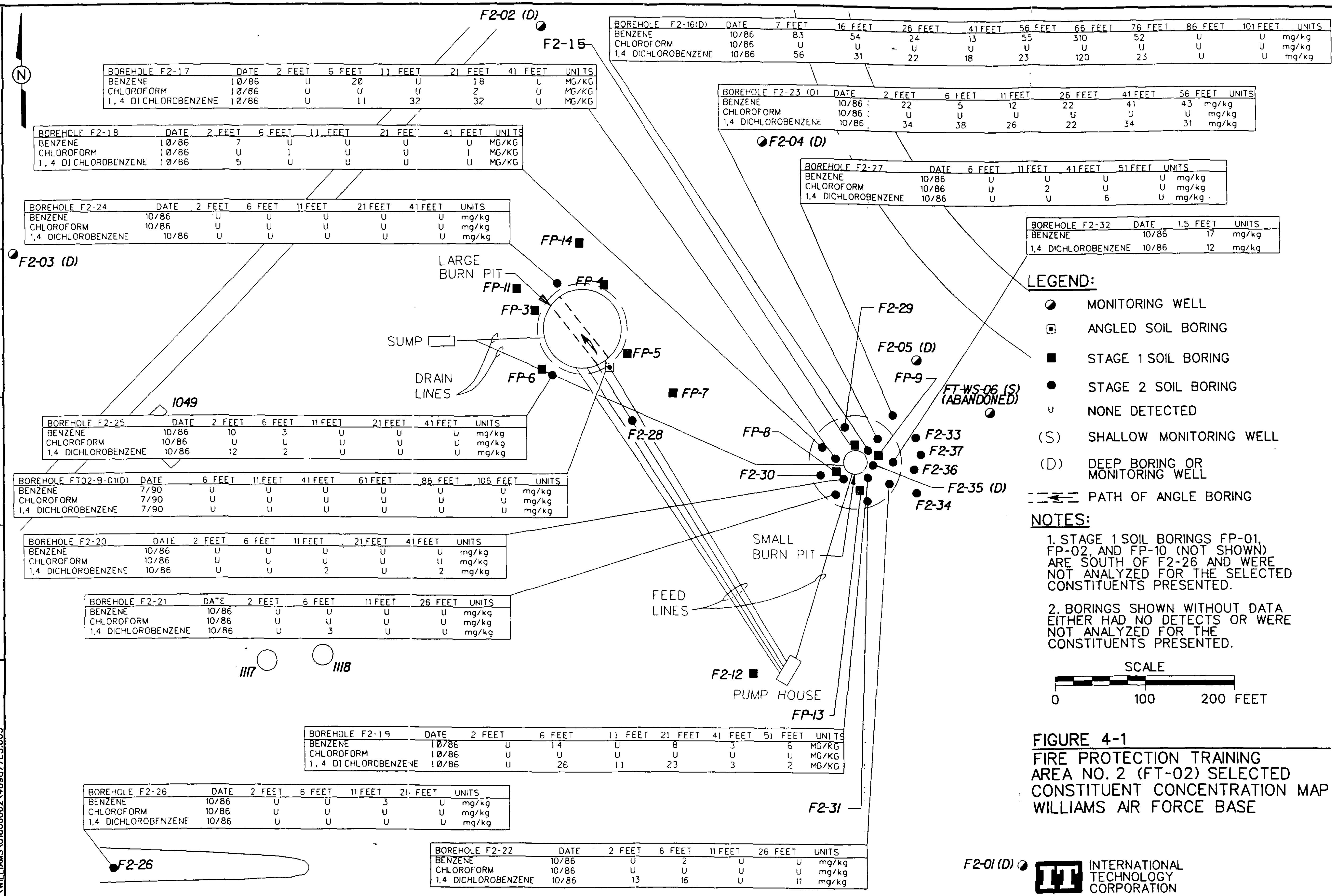
Various VOCs were detected in soils in the area of the small burn pit during the Phase II, Stage 2 sampling. Detected compounds include chlorinated benzenes at concentrations up to 120 milligrams per kilogram (mg/kg), benzene, toluene, ethyl benzene, and xylene (BTEX), with a maximum benzene concentration of 310 mg/kg at a depth of 76 feet below ground surface (bgs), and methyl ethyl ketone (MEK, or 2-butanone) at concentrations of 1,400 mg/kg. Total petroleum hydrocarbons (TPH) concentrations were also detected at a depth of 66 feet with concentrations of 84,000 mg/kg. Deep contamination is present only within the small burn pit and in areas surrounding it (Figure 4-1). Only slight surface soil contamination was found in the large burn pit. Low levels of various organic compounds, including methylene chloride, acetone, and bis(2-ethylhexyl)phthalate, all common laboratory contaminants, were detected at the large burn pit.

The presence of relatively high concentrations of TPH at depth in the small burn pit suggests that either a significant pathway exists for deep migration of chemicals at the small burn pit or that fire fighting practices differed significantly between the two pits. Cross sections are shown in Figures 4-2 and 4-3 which show the depths of contaminant detections at both burn pits. A summary of constituents detected in FT-02 soil samples is presented in Table 4-2. The estimated volume of impacted soils based on the areal extent and depth of contamination is approximately 25,000 cubic yards in the small burn pit and 230 cubic yards in the large burn pit.

Inorganic concentrations in soil samples collected from both burn pits were compared to background concentrations in Table 4-1. Mercury and cadmium were the only analytes that exceeded their respective regional and Base-specific background ranges. Mercury was detected in only one sample and appears to be an anomaly. Cadmium exceeded the normal ranges in four samples with a maximum concentration of 5 mg/kg.

Groundwater. Five groundwater monitoring wells were installed during Phase II, Stage 2 activities. A summary of the detected constituents in groundwater is presented in Table 4-3.

Various VOCs have been reported in several groundwater samples at low concentrations (maximum concentration of 6 micrograms per liter (μg/L). TPH have been reported at concentrations from 1,000 to 6,000 μg/L but no BTEX components were detected in these same samples. Recent groundwater samples collected in 1994 did not report any VOCs in the groundwater.



BOREHOLE F2-16(D)	DATE	7 FEET	16 FEET	26 FEET	41 FEET	56 FEET	66 FEET	76 FEET	86 FEET	101 FEET	UNITS
BENZENE	10/86	83	54	24	13	55	310	52	U	U	mg/kg
CHLOROFORM	10/86	U	U	U	U	U	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	56	31	22	18	23	120	23	U	U	mg/kg

BOREHOLE F2-17	DATE	2 FEET	6 FEET	11 FEET	21 FEET	41 FEET	UNITS
BENZENE	10/86	U	20	U	18	U	MG/KG
CHLOROFORM	10/86	U	U	U	2	U	MG/KG
1,4 DICHLOROBENZENE	10/86	U	11	32	32	U	MG/KG

BOREHOLE F2-23 (D)	DATE	2 FEET	6 FEET	11 FEET	26 FEET	41 FEET	56 FEET	UNITS
BENZENE	10/86	22	5	12	22	41	43	mg/kg
CHLOROFORM	10/86	U	U	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	34	38	26	22	34	31	mg/kg

BOREHOLE F2-18	DATE	2 FEET	6 FEET	11 FEET	21 FEET	41 FEET	UNITS
BENZENE	10/86	7	U	U	U	U	MG/KG
CHLOROFORM	10/86	U	1	U	U	1	MG/KG
1,4 DICHLOROBENZENE	10/86	5	U	U	U	U	MG/KG

BOREHOLE F2-27	DATE	6 FEET	11 FEET	41 FEET	51 FEET	UNITS
BENZENE	10/86	U	U	U	U	mg/kg
CHLOROFORM	10/86	U	2	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	U	U	6	U	mg/kg

BOREHOLE F2-24	DATE	2 FEET	6 FEET	11 FEET	21 FEET	41 FEET	UNITS
BENZENE	10/86	U	U	U	U	U	mg/kg
CHLOROFORM	10/86	U	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	U	U	U	U	U	mg/kg

BOREHOLE F2-32	DATE	1.5 FEET	UNITS
BENZENE	10/86	17	mg/kg
1,4 DICHLOROBENZENE	10/86	12	mg/kg

BOREHOLE F2-25	DATE	2 FEET	6 FEET	11 FEET	21 FEET	41 FEET	UNITS
BENZENE	10/86	10	3	U	U	U	mg/kg
CHLOROFORM	10/86	U	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	12	2	U	U	U	mg/kg

BOREHOLE FT02-B-01(D)	DATE	6 FEET	11 FEET	41 FEET	61 FEET	86 FEET	106 FEET	UNITS
BENZENE	7/90	U	U	U	U	U	U	mg/kg
CHLOROFORM	7/90	U	U	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	7/90	U	U	U	U	U	U	mg/kg

BOREHOLE F2-20	DATE	2 FEET	6 FEET	11 FEET	21 FEET	41 FEET	UNITS
BENZENE	10/86	U	U	U	U	U	mg/kg
CHLOROFORM	10/86	U	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	U	U	2	U	2	mg/kg

BOREHOLE F2-21	DATE	2 FEET	6 FEET	11 FEET	26 FEET	UNITS
BENZENE	10/86	U	U	U	U	mg/kg
CHLOROFORM	10/86	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	U	3	U	U	mg/kg

BOREHOLE F2-19	DATE	2 FEET	6 FEET	11 FEET	21 FEET	41 FEET	51 FEET	UNITS
BENZENE	10/86	U	14	U	8	3	6	MG/KG
CHLOROFORM	10/86	U	U	U	U	U	U	MG/KG
1,4 DICHLOROBENZENE	10/86	U	26	11	23	3	2	MG/KG

BOREHOLE F2-26	DATE	2 FEET	6 FEET	11 FEET	26 FEET	UNITS
BENZENE	10/86	U	U	3	U	mg/kg
CHLOROFORM	10/86	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	U	U	U	U	mg/kg

BOREHOLE F2-22	DATE	2 FEET	6 FEET	11 FEET	26 FEET	UNITS
BENZENE	10/86	U	2	U	U	mg/kg
CHLOROFORM	10/86	U	U	U	U	mg/kg
1,4 DICHLOROBENZENE	10/86	13	16	U	11	mg/kg

LEGEND:

- MONITORING WELL
- ANGLED SOIL BORING
- STAGE 1 SOIL BORING
- STAGE 2 SOIL BORING
- U NONE DETECTED
- (S) SHALLOW MONITORING WELL
- (D) DEEP BORING OR MONITORING WELL
- PATH OF ANGLE BORING

NOTES:

1. STAGE 1 SOIL BORINGS FP-01, FP-02, AND FP-10 (NOT SHOWN) ARE SOUTH OF F2-26 AND WERE NOT ANALYZED FOR THE SELECTED CONSTITUENTS PRESENTED.

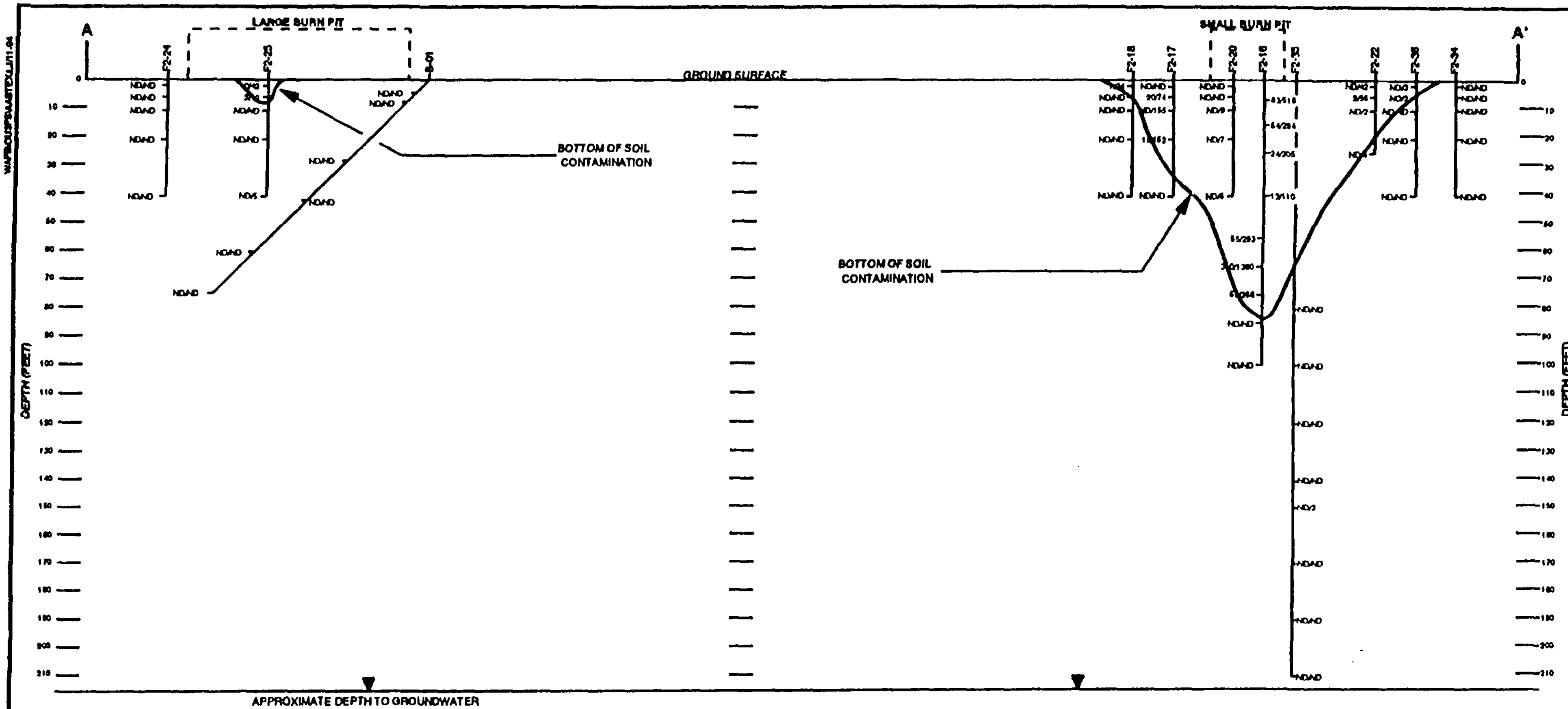
2. BORINGS SHOWN WITHOUT DATA EITHER HAD NO DETECTS OR WERE NOT ANALYZED FOR THE CONSTITUENTS PRESENTED.

FIGURE 4-1
FIRE PROTECTION TRAINING AREA NO. 2 (FT-02) SELECTED CONSTITUENT CONCENTRATION MAP WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

DWG. NO.: 409877ES.050 | PROJ. NO.: 409877 | INITIATOR: R. CLARK | PROJ. MGR.: | DRAFT. CHCK. BY: L. STOUT | ENGR. CHCK. BY: | DATE LAST REV.: | DRAWN BY: | STARTING DATE: 05-23-95 | DRAWN BY: PJONES

5-23-95 3:14PM PSJ
G:\WILLIAMS\01006002\409877ES.003



LEGEND:

F2-32 SOIL BORING NUMBER

54/284 SOIL SAMPLE ANALYTICAL RESULT FOR BENZENE/TOTAL BTEX (ppm)

ND COMPOUND(S) NOT DETECTED

SCALE:

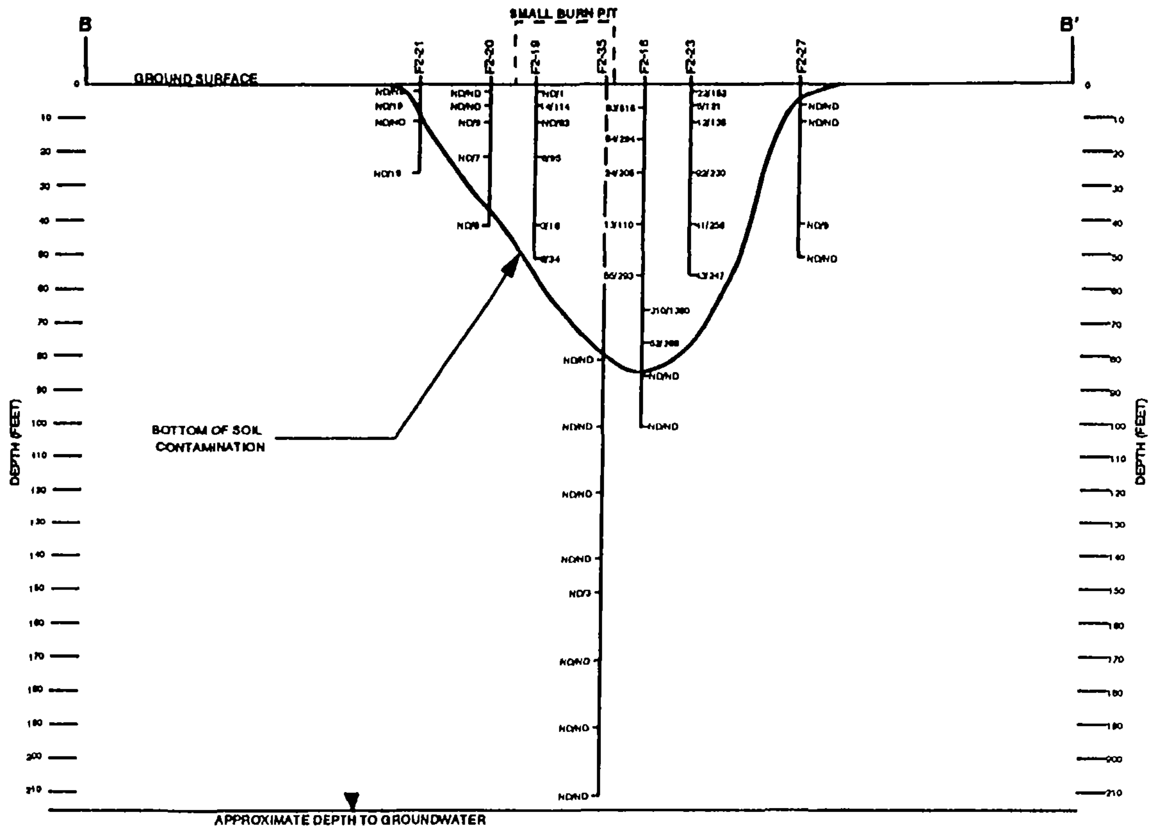
0 50 100 FEET

FIGURE 4 – 2

FIRE PROTECTION TRAINING AREA NO. 2 (FT-02) VERTICAL EXTENT OF BTEX CONTAMINATION IN SOIL; CROSS-SECTION A-A'

WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION



LEGEND:

F2-27 SOIL BORING NUMBER

84/294 SOIL SAMPLE ANALYTICAL RESULT FOR BENZENE/TOTAL BTEX (ppm)

ND COMPOUND(S) NOT DETECTED

SCALE:

0 50 100 FEET

FIGURE 4 – 3

FIRE PROTECTION TRAINING AREA NO. 2 (FT-02) VERTICAL EXTENT OF BTEX CONTAMINATION IN SOIL; CROSS-SECTION B-B'

WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

Table 4-2

Analytical Data Summary
Fire Protection Training Area No. 2, Soils
Williams Air Force Base

(Page 1 of 2)

Analyte	Frequency of Detection	Range of Detection Limits (mg/kg)	Range of Detected Concentrations (mg/kg)	Arithmetic Mean[a] (mg/kg)	Base-Specific Range of Background[b] (mg/kg)	Regional Range of Background[c] (mg/kg)
Organics						
1,1,1,2-Tetrachloroethane	1/64	1.0	1.0	1.0	NA[d]	NA
1,1-Dichloroethene	1/70	0.005 to 1.0	2.0	2.0	NA	NA
1,2-Dichlorobenzene	24/118	0.34 to 1.0	3.0 to 23.0	10.5	NA	NA
1,3-Dichlorobenzene	7/182	0.34 to 1.0	3.0 to 47.0	16.6	NA	NA
1,4-Dichlorobenzene	31/118	0.34 to 1.0	2.0 to 120.0	22.3	NA	NA
Acetone	6/6	0.011 to 0.012	0.01 to 0.029	0.017	NA	NA
Benzene	25/115	0.005 to 2.0	2.0 to 310.0	33.9	NA	NA
Bromoform	1/70	0.005 to 1.0	1.0	1.0	NA	NA
Bis(2-ethylhexyl)phthalate	5/9	0.34 to 0.40	0.078 to 2.3	0.97	NA	NA
Chlorobenzene	1/179	0.005 to 1.0	5.0	5.0	NA	NA
Chloroform	4/70	0.005 to 1.0	1.0 to 2.0	1.5	NA	NA
Ethyl benzene	39/115	0.005 to 1.0	1.0 to 170.0	15.9	NA	NA
Methyl ethyl ketone	22/70	0.011 to 10.0	13.0 to 1400	215.5	NA	NA
Methylene chloride	32/70	0.005 to 2.0	0.075 to 11.0	5.1	NA	NA
Toluene	28/115	0.005 to 2.0	3.0 to 260.0	34.8	NA	NA
Xylenes	41/115	0.005 to 2.0	2.0 to 640.0	69.5	NA	NA

Table 4-2

Analytical Data Summary
Fire Protection Training Area No. 2, Soils
Williams Air Force Base

(Page 2 of 2)

Analyte	Frequency of Detection	Range of Detection Limits (mg/kg)	Range of Detected Concentrations (mg/kg)	Arithmetic Mean[a] (mg/kg)	Base-Specific Range of Background[b] (mg/kg)	Regional Range of Background[c] (mg/kg)
Inorganics						
Cadmium	5/6	1.0 to 2.0	1.0 to 5.0	3.2	ND (<1)	0.01 to 2.0
Chromium	6/6	3.0	4.0 to 24	13.8	16.9 to 24.8	15 to 100
Copper	6/6	6.0 to 7.0	13 to 44	24.7	ND (<5)	15 to 200[e]
Lead	159/186	0.6 to 10	4.0 to 70	17.0	10.4 to 19.4	10 to 100
Mercury	1/6	0.3	5.3	5.3	ND (<0.2)	0.01 to 0.5[e]
Nickel	4/6	9.0 to 20	13 to 28	19.5	15.6 to 24.7	7 to 50
Zinc	6/6	5.0 to 6.0	33 to 100	62.3	ND (<4)	25 to 150

[a] Only detected concentrations were used to compute the arithmetic mean.
[b] Base-specific range for inorganics from site-specific background soil samples collected at Williams AFB in September 1993. The range represents the highs and lows for the ten samples collected.
[c] Data obtained from surficial soils in Gila, Maricopa, Pima, Pinal, and Yuma counties.
[d] NA = Not available or not used for comparison.
[e] Data obtained from B.J. Alloway, 1990.

NOTE: Total petroleum hydrocarbons (TPH) and oil and grease are not included in the risk assessment and are not summarized in this table. All data is presented in Appendix G of the OU-3 FS report.

Lead and zinc have been the only metals reported for any groundwater sample collected at FT-02. A summary is included in Table 4-3. Concentrations for both metals have exceeded background ranges. The samples that contained these analytes were collected in or prior to 1989. Groundwater samples collected in 1994 reported an estimated lead concentration of 2.2 µg/L (below detection limits) in one of four samples (zinc was not analyzed).

4.2 Southwest Drainage System

Soils. A total of 45 locations were sampled at SD-09 prior to 1993 (Figure 2-3), over several sampling events. Both organic and inorganic constituents were detected in soil samples collected. However, the organic results mainly reported common laboratory contaminants, including acetone and phthalates. Phenol and TPH have also been reported at relatively low concentrations.

Soil samples were collected in 1984, 1989, and 1991 for metals analysis at SD-09. Lead has been frequently detected in soil samples at concentrations similar to its background ranges, with limited exceptions. Additional information on this phase of work is discussed in the OU-1 RI report (IT, 1992). In 1993, a total of 49 soil samples were collected during more recent site work associated with storm line, OWS, and piping excavations along SD-09. Sample locations are shown in Figure 2-5. A summary of the results from the 1993 work is included in Table 4-4.

VOCs were reported in few samples collected in 1993. The highest detected concentration was 0.011 mg/kg of toluene. SVOCs were also detected. Four phthalates were detected relatively frequently, but at low concentrations. These compounds are suspected to have been introduced by the sample handling equipment, or by the laboratory during analysis.

Seven metals were detected in more than 40 percent of the samples collected (Table 4-4). Reported concentrations are generally within one order of magnitude of the Base-specific background ranges (Table 4-1). Lead was detected 48 of 49 samples collected in 1993, at a maximum concentration of 297 mg/kg. However, the 297 mg/kg detection is three times greater than other surface and subsurface samples collected in this area and areas downstream of the sample location. Therefore, this detection is considered to be an analytical anomaly. Only 2 of the 49 samples reported lead concentrations above the Arizona health-based guidance levels (HBGL) of 84 mg/kg. Figure 4-4 displays the majority of the lead detections along SD-09 during the 1993 sampling work.

Table 4-3

Analytical Data Summary
Fire Protection Training Area No. 2, Groundwater
Williams Air Force Base

Analyte	Frequency of Detection	Range of Detection Limits	Range of Detected Concentrations	Background Range[a]	Arithmetic Mean[b]
Organics (μg/L)					
Acetone	4/4	10.0	2.0 to 4.0	NA[c]	3.0
Carbon disulfide	2/4	5.0	1.0 to 6.0	NA	3.5
Methylene chloride	8/17	0.5 to 15.0	0.7 to 6.0	NA	2.7
Inorganics (μg/L)					
Lead	4/20	1.0 to 5.0	6.0 to 21.0	<10 to 14	10.05
Zinc	7/7	20.0	340.0 to 3800.0	<3 to 38	1330.0

[a]Data obtained from U.S. Geological Survey WATSTORE database using wells located within 10 miles of Williams AFB.
[b]Arithmetic mean was calculated using only detected concentrations.
[c]NA = Not available or not used for comparison.

Table 4-4

Analytical Data Summary
Southwest Drainage System (SD-09), Soils
OU-3 RI, October - December 1993
Williams Air Force Base

(Page 1 of 2)

Compound	Frequency of Detection[a]	Range of Detected Concentrations (mg/kg)	Base-Specific Range for Inorganics[b] (mg/kg)
Organics: VOCs			
1,1,1-Trichloroethane	1/34	0.002 to 0.002	NA[c]
Chlorobenzene	1/34	0.004 to 0.004	NA
Ethyl benzene	1/34	0.01 to 0.01	NA
Toluene	3/34	0.001 to 0.011	NA
Xylenes (total)	1/34	0.01 to 0.01	NA
Organics: SVOCs			
1,2,4-Trichlorobenzene	1/34	0.028 to 0.028	NA
2-Methylnaphthalene	1/34	0.089 to 0.089	NA
4-Chloro-3-methylphenol	1/34	0.031 to 0.031	NA
Acenaphthene	1/34	0.027 to 0.027	NA
Bis(2-ethylhexyl)phthalate	1/34	0.11 to 0.11	NA
Di-n-butyl phthalate	12/34	0.02 to 0.085	NA
Di-n-octyl phthalate	1/34	0.37 to 0.37	NA
Diethyl phthalate	16/34	0.019 to 0.31	NA
Pentachlorophenol	1/34	0.061 to 0.061	NA
Pyrene	2/34	0.024 to 0.094	NA
Inorganics: Priority Pollutant Metals			
Antimony	2/49	8.5 to 11.1	ND[d](<12)
Arsenic	34/43	0.46 to 5.7	2.3 to 4.3
Beryllium	28/49	0.5 to 2.2	1.0 to 1.6
Cadmium	18/49	0.95 to 6.3	ND(<1)
Chromium	49/49	15.1 to 49.8	16.9 to 24.8

Table 4-4

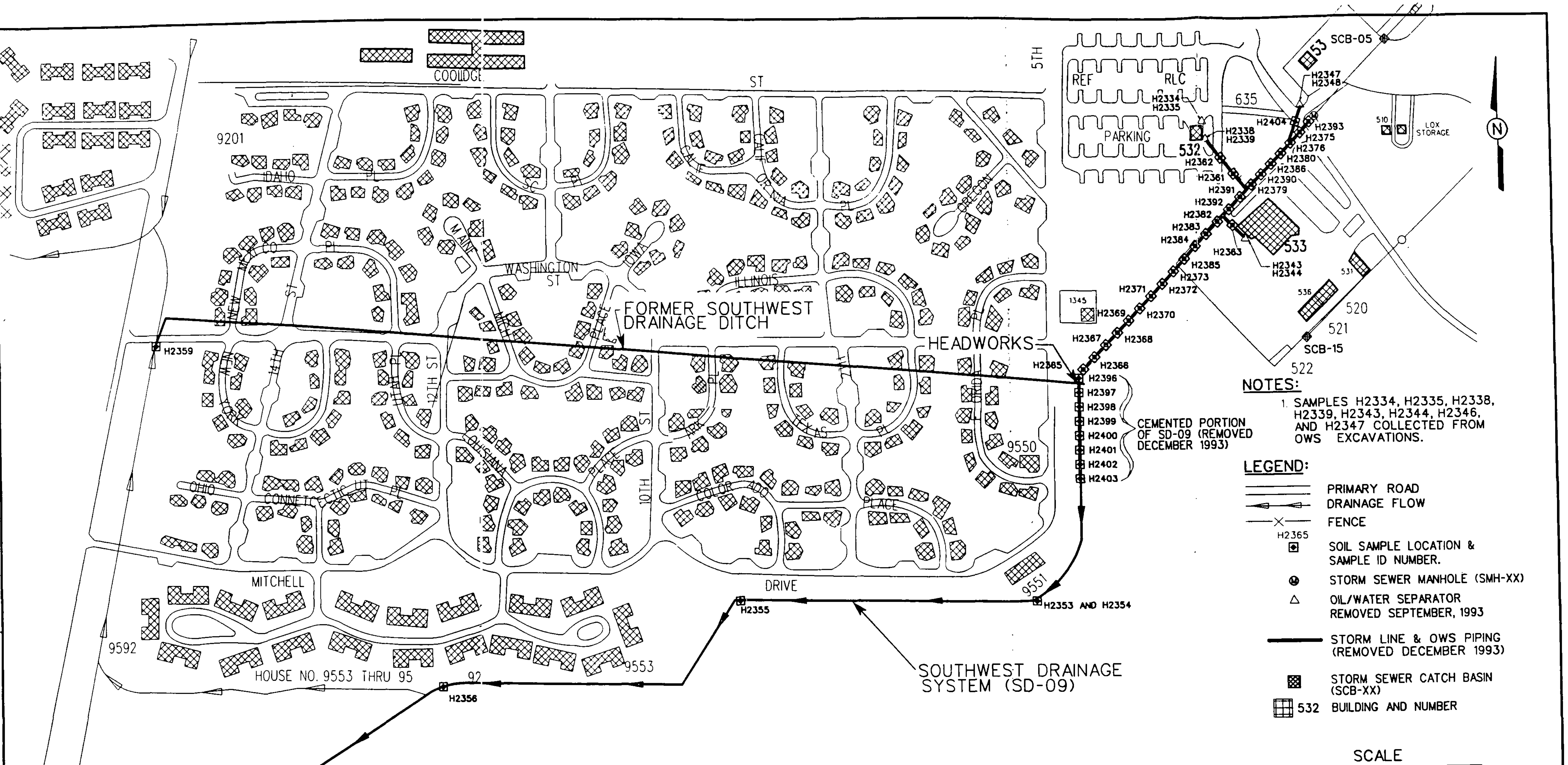
Analytical Data Summary
Southwest Drainage System (SD-09), Soils
OU-3 RI, October - December 1993
Williams Air Force Base

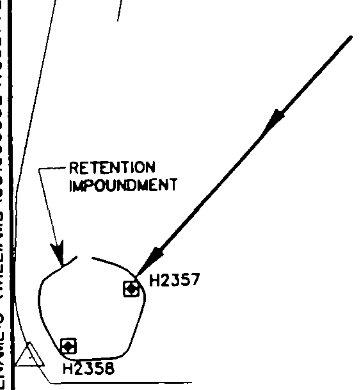
(Page 2 of 2)

Compound	Frequency of Detection[a]	Range of Detected Concentrations (mg/kg)	Base-Specific Range for Inorganics[b] (mg/kg)
Copper	49/49	7.1 to 47.8	ND(<5)
Lead	48/49	8.6 to 297	10.4 to 19.4
Nickel	49/49	9.5 to 31.5	15.6 to 24.7
Selenium	4/42	0.47 to 0.58	0.21 to 0.24
Silver	2/49	2.3 to 9.9	ND(<2)
Zinc	49/49	34.1 to 278	ND(<4)

[a]Rejected data not included in total number of samples.
[b]The average soil concentration represents the mean of surface soil samples plus one duplicate collected at Williams AFB in September 1993. The range represents the low and high values for the ten samples.
[c]NA = Not available or not used for comparison.
[d]ND = Nondetect (value is below contract detection limit).

DWG. NO.: 409877ES.051
PROJ. NO.: 409877
INITIATOR: R. CLARK
PROJ. MGR.: W.CARTER
DRAFT. CHCK. BY: G. PACHECO
ENGR. CHCK. BY: R. CLARK
DATE LAST REV.:
DRAWN BY:
STARTING DATE: 5-23-95
DRAWN BY: <P.JONES >>





SAMPLE NUMBER	DESCRIPTION	DEPTH (FT)	VALIDATED LEAD RESULT (MG/KG)	
H2334	OIL/WATER SEPARATOR, BLDG. 532, EXCAVATION 1	0.75	15.6	
H2335	OIL/WATER SEPARATOR, BLDG. 532 EXCAVATION 1	8.5	12.5	
H2336	OIL/WATER SEPARATOR, BLDG. 532, STOCKPILE	NA	14.9	
H2338	OIL/WATER SEPARATOR, BLDG. 532, EXCAVATION 2	8.0	16.6	
H2339	OIL/WATER SEPARATOR, BLDG. 532, EXCAVATION 2	10.0	9.5	U
H2340	OIL/WATER SEPARATOR, BLDG. 532, STOCKPILE	NA	25.0	
H2341	OIL/WATER SEPARATOR, BLDG. 532, STOCKPILE	NA	11.5	
H2343	OIL/WATER SEPARATOR, BLDG. 533,	10.5	14.3	
H2344	OIL/WATER SEPARATOR, BLDG. 533,	10.5	14.1	
H2345	OIL/WATER SEPARATOR, BLDG. 533, STOCKPILE	NA	19.0	
H2347	OIL/WATER SEPARATOR, BLDG. 53, EXCAVATION	8.0	81.1	
H2348	**OIL/WATER SEPARATOR, BLDG. 53, EXCAVATION**	**8.0**	**87.4**	
H2349	OIL/WATER SEPARATOR, BLDG. 53, STOCKPILE	NA	10.9	
H2350	OIL/WATER SEPARATOR, BLDG. 53, STOCKPILE	NA	13.0	
H2353	SD-09-01, IN STORM DRAIN DITCH BEHIND BLDG. 9551	0.5-1.0	33.2	
H2354	SD-09-01, IN STORM DRAIN DITCH BEHIND BLDG. 9551	0.5-1.0	72.5	
H2355	SD-09-02, SW STORM DRAIN	0.5-1.0	43.5	
H2356	SD-09-03, BEND IN DITCH, S. OF HOUSING AREA	0.5-1.0	297.0	
H2357	SD-09-04, NE CORNER OF IMPOUNDMENT AT SW END OF DITCH	0.5-1.0	29.7	
H2358	SD-09-05, SW CORNER OF IMPOUNDMENT AT SW END OF DITCH	0.5-1.0	26.7	
H2359	**SD-09-06, INTERSECTION 15TH & WASHINGTON STS.**	**0.5-1.0**	**21.7**	
H2361	OIL/WATER SEPARATOR, BLD 532, 2 FT BELOW BOTTOM OF IPE	5.833	11.9	
H2362	OIL/WATER SEPARATOR AT BLD 532, 2 FT BELOW BOTTOM OF PIPE	6.0	12.6	
H2363	OIL/WATER SEPARATOR, BLD 533, 2 FT BELOW BOTTOM OF PIPE	6.0	77.7	
H2365	11 FT FROM SD09 HEADWORKS (SCB-01) AT STORMLINE	5.41	11.0	
H2366	62 FT FROM SD09 HEADWORKS (SCB-01) AT STORMLINE	6.0	10.1	
H2367	NE OF SD09 HEADWORKS (SCB-01) AT STORMLINE	5.2	12.4	

SAMPLE NUMBER	DESCRIPTION	DEPTH (FT)	VALIDATED LEAD RESULT (MG/KG)	
H2368	NE OF SD09 HEADWORKS (SCB-01) AT STORMLINE	6.0	8.7	
H2369	NE OF SD09 HEADWORKS (SCB-01) AT STORMLINE	5.5	13.3	
H2370	NE OF SD09 HEADWORKS (SCB-01) AT STORMLINE	6.0	11.5	
H2371	NE OF SD09 HEADWORKS (SCB-01) AT STORMLINE	6.0	23.5	
H2372	NE OF SD09 HEADWORKS (SCB-01) AT STORMLINE	6.5	8.6	
H2373	NE OF SD09 HEADWORKS (SCB-01) AT STORMLINE	6.0	12.3	
H2375	STORMLINE BETWEEN BLDG. 53 AND 533	6.5	10.9	
H2376	STORMLINE BETWEEN BLDG. 53 AND 533	6.0	13.4	
H2379	STORMLINE NEAR BLDG. 53	6.0	16.5	
H2380	STORMLINE BETWEEN BLDG. 53 AND 533	6.0	13.4	
H2382	STORMLINE NEAR BLDG. 533	5.5	16.0	J
H2383	STORMLINE NEAR BLDG. 533	5.5	10.8	J
H2384	STORMLINE NEAR BLDG. 533	5.5	17.2	J
H2385	STORMLINE NEAR BLDG. 533	6.0	27.0	J
H2386	STORMLINE BETWEEN BLDG. 53 AND 533	6.5	10.4	J
H2390	STORMLINE NEAR BLDG. 533	6.0	31.7	J
H2391	STORMLINE NEAR BLDG. 533	6.0	15.9	J
H2392	STORMLINE NEAR BLDG. 533	6.0	17.6	J
H2393	STORMLINE BETWEEN BLDG.S 53 AND 533	6.0	19.8	J
H2396	SD-09 DRAINAGE DITCH	0-0.25	70.1	J
H2397	SD-09 DRAINAGE DITCH	0-0.25	65.2	J
H2398	SD-09 DRAINAGE DITCH	0-0.25	71.1	J
H2399	SD-09 DRAINAGE DITCH	0-0.25	71.9	J
H2400	SD-09 DRAINAGE DITCH	0-0.25	63.8	J
H2401	SD-09 DRAINAGE DITCH	0-0.25	75.0	J
H2402	SD-09 DRAINAGE DITCH	0.25	71.7	J
H2403	SD-09 DRAINAGE DITCH	0-0.25	57.5	J
H2404	STORMLINE, PIPING FROM OWS AT BLDG. 53	6.0	11.4	J

FIGURE 4-4
SD-09 DITCH AND STORM LINE LEAD CONCENTRATIONS 1993 CONFIRMATORY SAMPLING WILLIAMS AIR FORCE BASE

INTERNATIONAL TECHNOLOGY CORPORATION

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Groundwater. Results of previous and current sampling programs at SD-09 indicate that no extensive soil contamination exists along the length of the site. Therefore, groundwater beneath SD-09 was not monitored because there was no evidence of a pathway to groundwater from the soils.

4.3 Contaminant Fate and Transport

Detailed discussions of contaminant fate and transport for organic and inorganic constituents were presented in the OU-3 RI report (IT, 1994). A brief synopsis follows.

4.3.1 Contaminant Persistence in the Environment

Chemical persistence in environmental media is determined by the chemical's ability to move through a medium, to transfer from one medium to another, and to transform or degrade. These processes are controlled both by the chemical or element properties and the medium. Migration to groundwater can occur via water infiltration, dispersion, and diffusion. Sorption of chemicals onto soil particles or soil organic matter can reduce migration; similarly, chemically or biologically mediated transformation or degradation of chemicals can reduce migration.

Inorganics. All soils contain natural trace levels of metals so that their presence in soils is not necessarily indicative of contamination. Metals can be transformed (oxidized or reduced) so that mobility and toxicity are affected; however, metals cannot be biologically degraded. In the soil, the fate of metals can be found in one or more of the following (Shuman, 1991):

- Dissolved in the soil pore water
- Adsorbed on inorganic soil constituents
- Associated with insoluble soil organic matter
- Occupying exchange sites on inorganic constituents
- Precipitated as pure or mixture of solids.

Metals added to the soil react with the soil components in a variety of interrelated ways. These reaction mechanisms can generally be classified as inorganic and organic complexation/speciation, oxidation/reduction reactions, precipitation/dissolution reactions and adsorption/desorption reactions. The reaction mechanisms and rates both in soils and the water column depend on the type and amount of organic matter, clay, and hydrous oxides in the soil. Other factors include soil reaction potential (pH), exchangeable cations, oxidation/reduction potential (Eh), soil/water composition, infiltration rate, and chemical concentration.

Organics. The mobility of organic compounds within the soil is affected by chemical processes that are in part due to a chemical's volatility, octanol-water partition coefficient (a measure of the affinity of a chemical to partition from water to organic materials), water solubility, and concentration. In general, the more water insoluble a compound is, the more likely it is to adsorb on a sediment or organic surface. For several groups of compounds (including phenols, phthalates, and monocyclic aromatics such as benzene), volatilization, sorption, and biodegradation are all prominent processes. The behavior of PAH was found to be a function of the number of rings present. Important processes for this class of compound are sorption and aerobic and anaerobic biodegradation. The fate of chlorinated pesticides is determined by sorption, volatilization, and/or biotransformation.

4.3.2 Site-Specific Applications

A qualitative assessment of the transport potential based on chemical and physical properties, including concentration for the organic and inorganic analytes is presented in the following paragraphs for FT-02 and SD-09.

4.3.2.1 Fire Protection Training Area No. 2

Organic compounds detected in FT-02 soils are summarized in Table 4-2. Chemicals of potential concern (COPC) for soil are listed in Section 5.2.3.1. Each of the COPCs were detected at fairly deep zones at low concentrations. The fuel components BTEX were detected more frequently and at generally higher concentrations than other compounds. The deepest detection of a BTEX component was at 76 feet bgs, but not below this depth. Processes such as sorption, dispersion, and biodegradation will retard the movement potential of these organics. The activities at FT-02 have been stopped, thereby not adding any other compounds to the soil. BTEX has not been detected in any groundwater sample collected at FT-02.

Similar reasoning can be applied to other organic compounds detected in the soils. Compounds including MEK, acetone, and dichlorobenzene have been detected at some depth but at lower concentrations. Volatilization, sorption, degradation, and dispersion processes may preclude other organics from reaching groundwater (depth of 215 feet bgs) at concentrations that would exceed acceptable limits.

Inorganic analytes detected above background concentrations include cadmium, lead, and mercury. Mercury was detected in only one sample, which appears to be an anomaly. Lead was analyzed in soil samples collected from all FT-02 soil borings, whereas other metals were only analyzed in one boring (FT02-B-01). The subsurface soil at FT-02, as at other sites at Williams AFB contain high percentages of fine-grained sediments (silts and clays). Sorption of these inorganics onto the silts and clays is expected to greatly reduce their vertical migration potential.

4.3.2.2 Southwest Drainage System

Organic compounds detected at SD-09 are summarized in Table 4-4. Each compound was detected at relatively low concentrations and at shallow depths. The more volatile compounds were all detected at shallow depths. Below a depth of 20 feet, concentrations are very low (generally less than 0.020 mg/kg). At these low concentrations, dispersion will result in lower concentrations as any migration occurs. No impact to groundwater is anticipated based on the travel depth to groundwater (200 feet) and the dispersion process.

Semivolatile organic compounds (SVOC) such as phthalates, phenol, and pyrene were also detected between depths of 20 and 40 feet. Their physical properties such as low solubilities and sorption potentials, coupled with the distance to groundwater and the dispersion process, suggest that the overall impact to groundwater would be negligible or nonexistent.

Inorganic analytes were commonly detected in soil samples from SD-09. The potential for sorption to the soil and various oxidation potentials will reduce the likelihood for migration of metals to appreciable depths and at concentrations above background levels. Negative impacts to groundwater are not anticipated to occur from the concentrations detected at SD-09.

4.3.2.3 Discussion

Both FT-02 and SD-09 were in use for more than 30 years and it has been determined that the depth of contamination is limited; at FT-02 it is less than 100 feet, and at SD-09, approximately 40 feet. Introduction of any contaminants at either facility was sporadic in nature so that no continuous source of contamination was present. Therefore, no saturated conditions from the ground surface to the water table was likely to have ever existed.

FT-02 has been removed from use and any sources that could have contributed contaminants through SD-09 are no longer in service. No additional sources will be added to the subsurface through these two areas. The lack of additional sources and the absence of a saturated column will be the greatest inhibitors to any future downward migration of chemicals. Additional factors that will preclude migration are dispersion of chemicals, adsorption to the soil matrix and organic matter, biodegradation and biotransformation. Migration will cause a redistribution of contaminants and because concentrations are presently relatively small, concentrations will continue to decrease with any movement, as some will remain fixed on the soil profile or within pore spaces.

5.0 Summary of Potential Site Risks

5.1 Introduction

This chapter summarizes the baseline risk assessment and the identification of chemicals requiring remedial action for FT-02 and SD-09, which have been designated as part of OU-3. The risk assessment and the identification of chemicals for remedial action were performed as part of the RI/FS initiated by the USAF under the IRP. The details of the risk assessment and identification of chemicals for remedial action are outlined in, respectively, Chapter 6.0 of the OU-3 RI report (IT, 1994), and Chapter 2.0 of the OU-3 FS report (IT, 1995). The objective of this summary is to provide information to support the decision for a remedial action, or alternatively, for the no-further-action alternative. The risk assessment was conducted in accordance with the guidance documents: *Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A, Interim Final* (EPA, 1989a) and *Risk Assessment Guidance for Superfund, Human Health Risk Assessment: EPA Region IX Recommendations* (EPA, 1989b).

5.2 Identification of Chemicals of Potential Concern

Data collected during the RI were evaluated for use in the risk assessment in accordance with EPA guidelines. This process included evaluating the sample collection and analytical methods used, evaluating the quality of the data, and comparing data to background. The purpose of this selection process is to first identify those chemicals potentially harmful to human health if present at the site, identify those chemicals that are likely to be site-related and lastly, to evaluate the acceptability of the analytical data to be used in the quantitative risk assessment (EPA, 1989a). Some chemicals found during the sampling effort were eliminated from the list of COPCs based on the following criteria as recommended by the EPA (1989a,b):

- ***Frequency of Detection:*** Chemicals were eliminated if they were detected infrequently (5 percent or lower frequency of detection), providing there was no evidence that infrequent detection reflected a "hot spot" location. All remaining chemicals were evaluated for possible health effects.

- ***Background:*** Chemicals were eliminated from consideration if the range of the site-influenced values was within the range of Base-specific background values and the 95 percent upper confidence limit of the arithmetic mean concentration was below the appropriate EPA Region IX Preliminary Remediation Goal (PRG).

- ***Chemical Specificity:*** Chemicals were eliminated if they represented analytical results that were not specific for a particular compound (e.g., gross alpha, gross beta, TPH).

All inorganic chemicals were compared to Base-specific background ranges. All inorganics were selected as COPCs because site-related concentrations generally exceeded background concentrations.

The following sections present COPCs in soils and groundwater, by site. Groundwater from SD-09 was not sampled.

This evaluation and selection process is discussed in greater detail in Section 6.2 of the OU-3 RI report (EPA, 1994).

5.2.1 Chemicals of Potential Concern for Groundwater

5.2.1.1 Fire Protection Training Area No. 2

The effective precipitation for this area is small or nonexistent (Section 3.2, OU-3 RI report), minimizing the likelihood that infiltration from natural precipitation would transport chemicals to groundwater. The FT-02 area, however, was subjected to water application over a small surface area during the fire training exercises. This water could increase the likelihood of the downward transport of chemicals; therefore, groundwater beneath FT-02 was sampled.

Chemicals detected in groundwater samples from FT-02 are listed in Table 5-1. All chemicals detected within FT-02 were selected as COPCs. The five COPCs for FT-02 are:

- Acetone
- Carbon disulfide
- Lead
- Methylene chloride
- Zinc

5.2.1.2 Southwest Drainage System

The groundwater beneath SD-09 was not sampled because soils data collected during previous investigations indicate that there are no significant concentrations of chemicals present in the deep soils and, consequently, it is unlikely that groundwater is affected (Section 5.4.3, OU-3 RI report). In addition, the effective precipitation for the area is small or nonexistent, indicating that infiltration is an unlikely mechanism to transport soil contaminants to groundwater.

Table 5-1

Analytical Data Summary
Fire Protection Training Area No. 2 (FT-02), Groundwater
Williams Air Force Base

Analyte	Frequency of Detection	Range of Detection Limits (µg/L)	Range of Detected Concentrations (µg/L)	Regional Background Range[a] (µg/L)	UCL 95% Concentration (µg/L)
Organics					
*Acetone	4/4	10.0	2.0 to 4.0	NA[b]	4.3
*Carbon disulfide	2/4	5.0	1.0 to 6.0	NA	6.4
*Methylene chloride	8/13	0.5 to 5.0	0.7 to 6.0	NA	2.9
Inorganics					
*Lead	3/16	1.0 to 5.0	6.0 to 21.0	<10 to 14	6.5
*Zinc	7/7	20.0	340.0 to 3800.0	<3 to 38	2500.0

[a]Data obtained from U.S. Geological Survey WATSTORE database using wells located within 10 miles of Williams AFB.
[b]NA - Not available or not used for comparison.
* Chemical of potential concern.

5.2.2 Chemicals of Potential Concern for Soils

5.2.2.1 Fire Protection Training Area No. 2

Chemicals detected in soil samples from FT-02 are listed in Table 5-2.

The COPCs for soil in FT-02 are:

- 1,2-Dichlorobenzene
- 1,4-Dichlorobenzene
- Acetone
- Benzene
- Chloroform
- Ethyl benzene
- Bis(2-ethylhexyl)phthalate
- Methylene chloride
- Methyl ethyl ketone
- Toluene
- Xylenes
- Cadmium
- Copper
- Chromium
- Lead
- Mercury
- Nickel
- Zinc

5.2.2.2 Southwest Drainage System

Chemicals detected in soil samples from SD-09 are listed in Tables 5-3 (surface soil) and 5-4 (subsurface soil). Chromium analytical data, and data analysis, have been updated since the release of the OU-3 RI report; thus, chromium data presented in Table 5-3 reflect the most recent values, and differ from those presented in the OU-3 RI report. The COPCs for soil in SD-09 are:

- 1,1,1-Trichloroethane
- Acetone
- Bis(2-ethylhexyl)phthalate
- Di-n-butyl phthalate
- Diethyl phthalate
- Ethyl Alcohol
- Methylene Chloride
- Phenol
- Pyrene
- Toluene
- Antimony
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Copper
- Lead
- Nickel
- Mercury
- Selenium
- Silver
- Thallium
- Zinc.

Table 5-2

Analytical Data Summary
Fire Protection Training Area No. 2 (FT-02), Soils
Williams Air Force Base

(Page 1 of 2)

Analyte	Frequency of Detection	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentrations (mg/kg)	Base-Specific Range of Background[a] (mg/kg)	UCL Concentration (mg/kg)	Reason for Exclusion
Organics						
*1,2-Dichlorobenzene	14/73	0.36 to 1.0	0.36 to 23	NA	4.03	NR
1,3-Dichlorobenzene	5/114	0.36 to 1.0	0.36 to 47	NA	2.25	Frequency of detection is ≤ 5%
*1,4-Dichlorobenzene	19/73	0.36 to 1.0	0.36 to 56	NA	8.23	NR
*Acetone	2/2	0.011 to 0.012	0.01 to 0.02	NA	0.017	NR
*Benzene	15/73	0.005 to 2.0	0.01 to 83	NA	7.32	NR
*Bis(2-ethylhexyl)phthalate	2/2	0.36 to 0.39	0.19 to 1.2	NA	1.39	NR
Chlorobenzene	1/114	0.005 to 1.0	0.01 to 5.0	NA	0.61	Frequency of detection is ≤ 5%
*Chloroform	3/43	0.005 to 1.0	0.01 to 2.0	NA	0.66	NR
*Ethyl benzene	24/73	0.005 to 1.0	0.01 to 63	NA	6.64	NR
*Methyl ethyl ketone	13/42	0.011 to 10	0.01 to 610	NA	111.87	NR
*Methylene chloride	19/43	0.005 to 1.0	0.04 to 8	NA	3.04	NR
*Toluene	17/73	0.005 to 2.0	0.01 to 130	NA	9.41	NR
*Xylenes	25/73	0.005 to 2.0	0.01 to 240	NA	27.36	NR
Inorganics						
*Cadmium	1/2	2.0	2.0 to 4.0	ND (<1)	4.58	NR
*Chromium	2/2	3.0	14 to 16	16.9 to 24.8	16.38	NR

Table 5-2

Analytical Data Summary
Fire Protection Training Area No. 2 (FT-02), Soils
Williams Air Force Base

Analyte	Frequency of Detection	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentrations (mg/kg)	Base-Specific Range of Background[a] (mg/kg)	UCL Concentration (mg/kg)	Reason for Exclusion
*Copper	2/2	6.0 to 7.0	20	ND (<5)	20	NR
*Lead	133/144	0.7 to 10	4.0 to 70	10.4 to 19.4	17.99	NR
*Mercury	1/2	0.3	0.08 to 5.9	ND (<0.2)	7.01	NR
*Nickel	2/2	9.0 to 10	13 to 17	15.6 to 24.7	17.77	NR
*Zinc	2/2	5.0	51 to 60	ND (<4)	61.74	NR

[a] The average soil concentration represents the mean of nine surface soil samples plus one duplicate collected at Williams AFB in September 1993. The range represents the low and high value for the ten samples.
* Chemical of potential concern.
NA = Not available or not used for comparison.
ND = Not detected.
NR = Not relevant.

Table 5-3

Analytical Data Summary
Southwest Drainage System (SD-09), Surface Soils
Williams Air Force Base

Analyte	Frequency of Detection	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentration (mg/kg)	Base-Specific[a] Range of Background (mg/kg)	UCL Concentration (mg/kg)	Reason for Exclusion
Organics						
*1,1,1-Trichloroethane	4/41	0.005 to 0.01	0 to 0.012	NA	0.004	NR
2-Butanone	1/45	0.005 to 0.012	0 to 0.016	NA	0.022	Frequency of detection ≤ 5% when combined with subsurface soil samples
4-Methyl-2-pentanone	1/41	0.01 to 0.05	0 to 0.012	NA	0.023	Frequency of detection ≤ 5% when combined with subsurface soil samples
*Acetone	4/10	0.01 to 0.012	0.011 to 0.21	NA	0.083	NR
Benzo(b)fluoranthene	1/10	0.33 to 0.39	0 to 0.38	NA	0.19	Frequency of detection ≤ 5% when combined with subsurface soil samples
*Bis(2-ethylhexyl)phthalate	6/10	0.33 to 0.39	0.02 to 3	NA	1.037	NR
Butyl benzyl phthalate	1/10	0.33 to 0.39	0 to 0.38	NA	0.189	Frequency of detection ≤ 5% when combined with subsurface soil samples
Di-n-octyl phthalate	1/10	0.33 to 0.39	0 to 0.39	NA	0.186	Frequency of detection ≤ 5% when combined with subsurface soil samples
*Diethyl phthalate	2/10	0.33 to 0.39	0 to 0.39	NA	0.185	NR
Dimethyl phthalate	1/10	0.33 to 0.39	0 to 0.39	NA	0.188	Frequency of detection ≤ 5% when combined with subsurface soil samples
*Ethyl alcohol	1/31	0.05	0 to 0.11	NA	0.033	NR

Table 5-3

Analytical Data Summary
Southwest Drainage System (SD-09), Surface Soils
Williams Air Force Base

Analyte	Frequency of Detection	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentration (mg/kg)	Base-Specific[a] Range of Background (mg/kg)	UCL Concentration (mg/kg)	Reason for Exclusion
Fluoranthene	1/10	0.33 to 0.39	0 to 0.39	NA	0.183	Frequency of detection ≤ 5% when combined with subsurface soil samples
*Methylene chloride	4/10	0.005 to 0.01	0.011 to 0.13	NA	0.055	NR
Oil and Grease	2/4	50	0 to 100	NA	99.25	Chemical specificity
*Phenol	1/14	0.33 to 0.5	0 to 1.1	NA	0.38	NR
*Pyrene	1/10	0.33 to 0.39	0 to 0.38	NA	0.187	NR
*Toluene	4/44	0.005 to 0.01	0 to 0.012	NA	0.003	NR
Total organic halogens	3/4	1	0 to 7	NA	4.999	Chemical specificity
Total petroleum hydrocarbons	4/4	2	3 to 49	NA	34.48	Chemical specificity
Inorganics						
*Antimony	5/16	12	11 to 68	ND (<12)	30.2	NR
*Arsenic	10/18	2 to 3	0 to 5	2.3 to 4.3	2.5	NR
*Beryllium	19/25	1 to 2	0 to 2.2	1.0 to 1.6	1.22	NR
*Cadmium	25/31	0.2 to 2	0 to 90	ND (<1)	12.39	NR
*[b]Chromium	28/28	2 to 5	17.6 to 49.8	16.9 to 24.8	33.2	NR

Table 5-3

Analytical Data Summary
Southwest Drainage System (SD-09), Surface Soils
Williams Air Force Base

Analyte	Frequency of Detection	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentration (mg/kg)	Base-Specific[a] Range of Background (mg/kg)	UCL Concentration (mg/kg)	Reason for Exclusion
*Copper	29/29	0.4 to 5	14.1 to 47.8	ND (<5)	33.32	NR
*Lead	28/28	0.6 to 2	10.9 to 96	10.4 to 19.4	53.39	NR
*Mercury	2/25	0.2	0 to .19	ND (<0.2)	0.11	NR
*Nickel	25/25	8	13.2 to 31.5	15.6 to 24.7	25.8	NR
*Selenium	4/18	1 to 2	0 to 0.58	0.21 to 0.24	0.675	NR
*Silver	4/25	2 to 3	0 to 13	ND (<2)	2.52	NR
*Thallium	2/18	2 to 3	0 to 0.9	ND (<2)	1.149	NR
*Zinc	25/25	4	52 to 278	ND (<4)	152.522	NR

[a]The average soil concentration represents the mean of nine surface soil samples plus one duplicate collected at Williams AFB on September 1993. The range presents the low and high values for the ten samples.
[b]Updated values, differing from value reported in Chapter 6 of OU-3 RI (see section 5.2.3.2)
* Chemical of potential concern.
NA = Not available.
ND = Not detected.
NR = Not relevant.

Table 5-4

Analytical Data Summary
Southwest Drainage System (SD-09), Subsurface Soils
Williams Air Force Base

(Page 1 of 2)

Analyte	Frequency of Detection	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentration (mg/kg)	Base-Specific[a] Range of Background (mg/kg)	UCL Concentration (mg/kg)	Reason for Exclusion
Organics						
*1,1,1-Trichloroethane	1/82	0.005 to 0.013	0 to 0.012	NA	0.004	NR
1,2,4-Trichlorobenzene	1/51	0.33 to 1.7	0 to 0.41	NA	0.300	Frequency of detection ≤ 5%
2-Methylnaphthalene	1/51	0.33 to 1.7	0 to 0.41	NA	0.291	Frequency of detection ≤ 5%
4-Chloro-3-methylphenol	1/51	0.33 to 1.7	0 to 0.41	NA	0.300	Frequency of detection ≤ 5%
Acenaphthene	1/51	0.33 to 1.7	0 to 0.41	NA	0.300	Frequency of detection ≤ 5%
*Acetone	16/51	0.01 to 0.025	0 to 0.032	NA	0.005	NR
Benzene	1/86	0.005 to 0.013	0 to 0.012	NA	0.004	Frequency of detection ≤ 5%
*Bis(2-ethylhexyl)phthalate	16/51	0.33 to 1.7	0 to 18	NA	4.23	NR
Bromodichloromethane	1/83	0.005 to 0.013	0 to 0.012	NA	0.004	Frequency of detection ≤ 5%
Butyl benzyl phthalate	1/51	0.33 to 1.7	0 to 0.41	NA	0.29	Frequency of detection ≤ 5%
Chlorobenzene	1/118	0.005 to 0.013	0 to 0.012	NA	0.004	Frequency of detection ≤ 5%
*Di-n-butyl phthalate	13/51	0.33 to 1.7	0 to 0.4	NA	0.265	NR
*Diethyl phthalate	17/51	0.33 to 1.7	0 to 0.41	NA	0.27	NR
*Ethyl alcohol	5/32	0.05	0 to 0.11	NA	0.042	NR
Ethyl benzene	1/86	0.005 to 0.013	0 to 0.012	NA	0.004	Frequency of detection ≤ 5%
*Methylene chloride	17/51	0.005 to 0.013	0.005 to 0.11	NA	0.009	NR
Oil and Grease	1/4	50	0 to 130	NA	95.81	Chemical specificity
Pentachlorophenol	1/51	0.8 to 8	0 to 1	NA	1.17	Frequency of detection ≤ 5%
*Phenol	8/55	0.33 to 1.7	0 to 1	NA	0.29	NR
*Pyrene	2/51	0.33 to 1.7	0 to 0.41	NA	0.289	NR

Table 5-4

Analytical Data Summary
Southwest Drainage System (SD-09), Subsurface Soils
Williams Air Force Base

Analyte	Frequency of Detection	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentration (mg/kg)	Base-Specific[a] Range of Background (mg/kg)	UCL Concentration (mg/kg)	Reason for Exclusion
*Toluene	5/86	0.005 to 0.013	0 to 0.012	NA	0.004	NR
Total petroleum hydrocarbons	10/15	2	0 to 20	NA	8.71	Chemical specificity
Xylenes (total)	1/86	0.005 to 0.013	0 to 0.012	NA	0.004	Frequency of detection ≤ 5%
Inorganics						
*Antimony	15/34	12 to 20	0 to 46	ND (<12)	21.64	NR
*Arsenic	42/52	2 to 5	0 to 5.7	2.3 to 4.3	2.52	NR
*Beryllium	16/51	1 to 3	0 to 2.1	1.0 to 1.6	0.78	NR
*Cadmium	7/55	0.2 to 3	0 to 6.3	ND (<1)	1.08	NR
*Chromium	57/57	2 to 5	12 to 53	16.9 to 24.8	21.77	NR
*Copper	54/55	0.4 to 6	0 to 61	ND (<5)	19.15	NR
*Lead	54/55	0.6 to 2	8 to 87.4	10.4 to 19.4	22.87	NR
*Nickel	51/51	8	9 to 25.9	15.6 to 24.7	18.09	NR
*Silver	2/51	2 to 5	0 to 9.9	ND (<2)	1.62	NR
*Thallium	1/51	2 to 30	0 to 0.95	ND (<2)	3.45	NR
*Zinc	51/51	4	28 to 233	ND (<4)	64.8	NR

[a]The average soil concentration represents the mean of nine surface soil samples plus one duplicate collected at Williams AFB in September 1993. The range presents the low and high value for the ten samples.
* Chemical of potential concern.
NA = Not available or not used for comparison.
ND = Not detected.
NR = Not relevant.

5.2.3 *Uncertainties*

Uncertainties associated with the collection and laboratory analysis of the sampling data may impact the results of the selection process. These uncertainties result from the possible contamination of samples during collection, preparation, or analysis, and normal variation in the analytical techniques and could result in over- or underestimation of contaminant concentrations. These uncertainties are minimized by the laboratory validation process.

5.3 *Exposure Assessment*

This section presents the estimation of potential exposures of human or environmental receptors to chemicals found at the site. Exposure is defined as the contact of a receptor with a chemical. Exposure assessment is the estimation of the magnitude, frequency, and duration of contact for each identified route of exposure. The magnitude of an exposure is determined by estimating the amount of chemical available at the receptor exchange boundaries (i.e., lungs, gastrointestinal tract, or skin) during a specified time period. The general procedure for conducting an exposure assessment is (EPA, 1989a):

- Characterization of exposure setting
- Identification of potential exposure pathways
- Quantification of exposure (where possible).

5.3.1 *Receptor Assessment*

The objective of the receptor assessment is to identify potential human and environmental populations that may be exposed to site-related chemicals at the Base under current and future land-use conditions. The assessment considers both on- and off-Base populations and their relationship to the potential migration pathways for site-related chemicals.

On-Base Land Use. The Base is relatively small when compared to most USAF bases. It was closed on September 30, 1993 and transitioned from the Air Force's ATC to the Air Force Base Conversion Agency. This agency is working with the local community through the RAB and the Williams Redevelopment Partnership. The Partnership will maximize reuse for aviation, education, commercial, and industrial uses. The Base has been divided into potential reuse parcels identified as airfield, commercial, aviation support, air cargo, general industrial, education/research/training, institutional/medical, and schools. The golf course has been leased. Leases are being negotiated for several industrial areas. Universities are also considering establishing portions of their campuses at the Base. Because the Base is closed, land use at the site could become residential, commercial, and/or agricultural.

There are two categories of potential receptors: (1) occupational receptors are those potentially exposed as a result of activities associated with duty assignments; (2) residential receptors are those potentially exposed as a result of living on the Base. The Base is fenced, with security guards at the entrance, and is currently inaccessible to off-Base populations.

Future exposures to residential receptors will also be considered under the assumption that the Base property will be developed for residential purposes now that the Base has closed. It is assumed that future residential populations will also include sensitive subpopulations such as infants, children, elderly persons, and pregnant and nursing women.

Off-Base Land Use. The Base is relatively isolated from any large metropolitan area. Located in Maricopa County, it is surrounded mostly by agricultural land, which has had a long history of intensive uses, predominantly production of citrus, cotton, and alfalfa. Smaller urban areas such as the City of Mesa, the Town of Gilbert, and the City of Apache Junction are located 5 to 15 miles northeast and northwest of the Base (Section 3.7.2, OU-3 RI report).

5.3.2 Identification of Potential Exposure Pathways

For exposures to occur, complete exposure pathways must exist. A complete exposure pathway requires (EPA, 1989a):

- A source and mechanism for release of the chemical
- An environmental transport pathway
- A point of potential human contact
- An exposure route at the exposure point.

If any one of these four components is absent, then an exposure pathway is incomplete. The conceptual exposure model for OU-3, providing a visual overview of all the potential exposure pathways considered here, is presented in Figure 5-1. The following sections describe the potential exposure pathways for each of the OU-3 sites evaluated at the Base.

5.3.2.1 Fire Protection Training Area No. 2

All potential pathways included in the risk assessment for current and future land use, off- and on-base, are summarized in Table 5-5.

5.3.2.2 Southwest Drainage System

All potential pathways included in the risk assessment for current an future land use, off- and on-base, are summarized in Table 5-6.

Figure 5-1
Conceptual Exposure Model For OU-3
Williams Air Force Base

SITE	SOURCE MEDIUM	PRIMARY RELEASE/ TRANSPORT	EXPOSURE MEDIUM	EXPOSURE ROUTE	HYPOTHETICAL RECEPTOR: Current Land Use – Occupational	Current Land Use – Residential	Future Land Use – Occupational	Future Land Use – Residential
FT-02	SOIL		Soil	Incidental ingestion	●	3	4	●
				Dermal contact	●	3	4	●
		Resuspension/ volatilization	Air	Inhalation (dust, VOCs)	●	3	4	●
	GROUNDWATER		Water	Ingestion	1	2	4	●
				Dermal contact	1	2	4	●
		Volatilization	Air	Inhalation	1	2	4	●
SD-09	SOIL		Soil	Incidental ingestion	●	●	4	●
				Dermal contact	●	●	4	●
		Resuspension/ volatilization	Air	Inhalation (dust, VOCs)	●	●	4	●

● = Potentially complete exposure pathway

1 = Current occupational receptors are not exposed to FT-02 groundwater.

2 = Although off-base receptors may be exposed to FT-02 groundwater, to date no chemicals of concern have been detected in Base production wells and there are no production wells in FT-02 area.

3= Currently; off-base residents do not have access to FT-02 soils.

4 = It was assumed that future development would be residential, precluding the need for evaluating occupational exposure.

Table 5-5

Summary of Potential Exposure Pathways
Fire Protection Area No. 2 (FT-02)
Williams Air Force Base

Potentially Exposed Populations	Exposure Pathway	Inclusion in Risk Assessment	Reason for Selection or Exclusion
CURRENT LAND USE			
Groundwater			
Base Residents/Base Workers	Ingestion of groundwater from downgradient wells	No	There are currently no production wells in the contaminated area. No route for exposure exists.
Base Residents/Base Workers	Inhalation of chemicals volatilized from water during home use	No	There are currently no production wells in the contaminated area. No route for exposure exists.
Base Residents/Base Workers	Dermal contact with chemicals in water during home use	No	There are currently no production wells in the contaminated area. No route for exposure exists.
Base Residents	Ingestion of vegetables contaminated by irrigation	No	There are currently no production wells in the contaminated area. No route for exposure exists.
Soil			
Base Residents	Incidental ingestion of soil	No	Currently there are no residents that have access to area soils.
Base Residents	Dermal contact with soil	No	Currently there are no residents that have access to area soils.
Base Residents	Inhalation of chemicals volatilized from the soil	No	Currently there are no residents that have access to area soils.
Base Residents	Inhalation of fugitive dust	No	Currently there are no residents that have access to area soils.
Base Residents	Ingestion of vegetables grown on contaminated soil	No	Currently there are no residents that have access to area soils.
Base Workers	Incidental ingestion of soil	Yes	Workers may be potentially exposed during soil-moving or other activities in the area.
Base Workers	Dermal contact with soil	Yes	Base workers may be potentially exposed during soil-moving or other activities in the area.
Base Workers	Inhalation of chemicals volatilized from the soil	Yes	Base workers may be potentially exposed during soil-moving or other activities in the area.
Base Workers	Inhalation of fugitive dust	Yes	Base workers may be potentially exposed during soil-moving or other activities in the area.

Table 5-5

Summary of Potential Exposure Pathways
Fire Protection Area No. 2 (FT-02)
Williams Air Force Base

Potentially Exposed Populations	Exposure Pathway	Inclusion in Risk Assessment	Reason for Selection or Exclusion
FUTURE LAND USE			
Groundwater			
Residents	Ingestion of groundwater from downgradient wells	Yes	Application of water during fire training exercises could have leached constituents to ground-water. The construction of a production well in this area would enable contact with the water.
Residents	Inhalation of chemicals volatilized from water during home use	Yes	Application of water during fire training exercises could have leached constituents to ground-water. The construction of a production well in this area would enable contact with the water.
Residents	Dermal contact with chemicals in water during home use	Yes	Application of water during fire training exercises could have leached constituents to ground-water. The construction of a production well in this area would enable contact with the water.
Residents	Ingestion of vegetables contaminated by irrigation	Yes (Qualitative)	Application of water during fire training exercises could have leached constituents to ground-water. The construction of a production well in this area would enable contact with the water.
Soil			
Residents	Incidental ingestion of soil	Yes	There is the potential for residential development of the Base property after closure. Therefore, contact with the soil will be possible.
Residents	Dermal contact with soil	Yes	There is the potential for residential development of the Base property after closure. Therefore, contact with the soil will be possible.

Table 5-5

Summary of Potential Exposure Pathways
Fire Protection Area No. 2 (FT-02)
Williams Air Force Base

(Page 3 of 3)

Potentially Exposed Populations	Exposure Pathway	Inclusion in Risk Assessment	Reason for Selection or Exclusion
Residents	Inhalation of chemicals volatilized from the soil	Yes	There is the potential for residential development of the Base property after closure. Low levels of volatiles were detected in soil. Increased disturbance of soil may result in exposure.
Residents	Inhalation of fugitive dust	Yes	There is the potential for residential development of the Base property after closure. Low levels of chemicals of potential concern were identified. Increased disturbance of soil may result in exposure.
Residents	Ingestion of homegrown vegetables	Yes (Qualitative)	There is the potential for residential development of the Base property after closure. Therefore, contact with the soil will be possible.

Table 5-6

Summary of Potential Exposure Pathways
Southwest Drainage System (SD-09)
Williams Air Force Base

Potentially Exposed Populations	Exposure Pathway	Inclusion in Risk Assessment	Reason for Selection or Exclusion
CURRENT LAND USE			
Groundwater			
Base Residents/Base Workers	Ingestion of groundwater from downgradient wells	No	There are currently no production wells in the contaminated area. No route for exposure exists.
Base Residents/Base Workers	Inhalation of chemicals volatilized from water during home use	No	There are currently no production wells in the contaminated area. No route for exposure exists.
Base Residents/Base Workers	Dermal contact with chemicals in water during home use	No	There are currently no production wells in the contaminated area. No route for exposure exists.
Base Residents	Ingestion of vegetables contaminated by irrigation	No	There are currently no production wells in the contaminated area. No route for exposure exists.
Soil			
Base Residents (Children)	Incidental ingestion of soil	Yes	Children may be potentially exposed due to accessibility and proximity of the area to Base housing.
Base Residents (Children)	Dermal contact with soil	Yes	Children may be potentially exposed due to accessibility and proximity of the area to Base housing.
Base Residents (Children)	Inhalation of chemicals volatilized from the soil	Yes	Children may be potentially exposed due to accessibility and proximity of the area to Base housing.
Base Residents (Children)	Inhalation of fugitive dusts	Yes	Children may be potentially exposed due to accessibility and proximity of the area to Base housing.

Table 5-6

Summary of Potential Exposure Pathways
Southwest Drainage System (SD-09)
Williams Air Force Base

Potentially Exposed Populations	Exposure Pathway	Inclusion in Risk Assessment	Reason for Selection or Exclusion
Base Workers	Incidental ingestion of soil	Yes	Workers may be potentially exposed during soil-moving or other activities in the area.
Base Workers	Dermal contact with soil	Yes	Workers may be potentially exposed during soil-moving or other activities in the area.
Base Workers	Inhalation of chemicals volatilized from the soil	Yes	Workers may be potentially exposed during soil-moving or other activities in the area.
Base Workers	Inhalation of fugitive dust	Yes	Workers may be potentially exposed during soil-moving or other activities in the area.
FUTURE LAND USE			
Groundwater			
Residents	Ingestion of groundwater from downgradient wells	No	Transport of chemicals from the soil to the groundwater is not expected. Therefore, the exposure route is not expected to be complete.
Residents	Inhalation of chemicals volatilized from water during home use	No	Transport of chemicals from the soil to the groundwater is not expected. Therefore, the exposure route is not expected to be complete.
Residents	Dermal contact with chemicals in water during home use	No	Transport of chemicals from the soil to the groundwater is not expected. Therefore, the exposure route is not expected to be complete.
Residents	Ingestion of vegetables contaminated by irrigation	No	Transport of chemicals from the soil to the groundwater is not expected. Therefore, the exposure route is not expected to be complete.

Table 5-6

Summary of Potential Exposure Pathways
Southwest Drainage System (SD-09)
Williams Air Force Base

Potentially Exposed Populations	Exposure Pathway	Inclusion in Risk Assessment	Reason for Selection or Exclusion
Soil			
Residents	Incidental ingestion of soil	Yes	There is the potential for residential development of the Base property after closure. Therefore, contact with the soil will be possible.
Residents	Dermal contact with soil	Yes	There is the potential for residential development of the Base property after closure. Therefore, contact with the soil will be possible.
Residents	Inhalation of chemicals volatilized from the soil	Yes	There is the potential for residential development of the Base property after closure. Increased disturbance of soil may result in exposure.
Residents	Inhalation of fugitive dust	Yes	There is the potential for residential development of the Base property after closure. Increased disturbance of soil may result in exposure.
Residents	Ingestion of homegrown vegetables	Yes (Qualitative)	There is the potential for residential development of the Base property after closure. Therefore, contact with the soil will be possible.

5.3.2.3 Ingestion of Homegrown Fruits and Vegetables

Potential risk associated with the ingestion of homegrown fruits or vegetables irrigated with groundwater and grown in site soil was evaluated qualitatively because it was concluded (Section 6.3.2.3, OU-3 RI report) that it is unlikely that the Base would be used for agricultural purposes.

5.3.3 Estimation of Exposure

This section describes the concentration estimation of individual site-related COCs that may reach human receptors. The process involves:

- Identifying applicable human exposure models and input parameters
- Determining the concentration of each chemical in the identified environmental medium at the point of human exposure
- Estimating human intakes.

The methodologies and parameter values that will be used to quantitatively estimate chemical intakes for the risk assessment are presented in the following sections. In general, the magnitude of chemical intake depends on the exposure pathway and the variables that impact the transmittal of chemicals via that pathway. These intake estimates will be used in conjunction with chemical toxicity data to quantify the risks associated with each pathway.

For each identified pathway, a reasonable maximum exposure (RME) scenario has been developed. This scenario gives a reasonable upper-bound estimate of the potential magnitude of an individual exposure to chemicals from the site. The intent of the RME as defined by the EPA (1989a; 1991a) is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures. This RME approach replaces the previous EPA recommendation for evaluating both an average and worst-case scenario. The RME is estimated from a combination of average and upper-bound exposure assumptions to result in a reasonable maximum.

5.3.3.1 Exposure Models

The primary source for the exposure models used for this risk assessment is the *Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A, Interim Final* (EPA, 1989a). The magnitude of chemical intake via the following exposure pathways is estimated by exposure models presented in detail in the RI report:

- Ingestion of drinking water
- Incidental ingestion of soil
- Inhalation of fugitive dust or vapor phase organic compounds in soil
- Inhalation of chemicals in indoor air due to volatilization from groundwater
- Dermal contact with soil and water.

5.3.3.2 Exposure Parameters

A combination of RME and average exposure parameters has been used in each scenario to result in a combined RME. The exposure parameters used and whether they are average or upper-bound values are summarized in Table 5-7. Upper-bound values are generally 90th or 95th percentile values depending on availability for that parameter.

5.3.3.3 Exposure-Point Concentrations

The exposure-point concentration is the concentration of a chemical in an exposure medium that may be contacted by a receptor. Determination of the exposure-point concentration depends on factors such as:

- Availability of data from which an exposure-point concentration can be determined

- Statistical methodologies selected to determine the appropriate exposure-point concentration

- Potential contributions to chemical concentrations not attributed to the site

- Contamination release and transport factors

- Location of potential receptors.

Exposure concentrations for the COPCs in groundwater, soil, and air are listed in Tables 5-8 and 5-9 for the Fire Protection Training Area No. 2 and Southwest Drainage System, respectively. A description of the approach used to estimate exposure concentrations is given in the following paragraphs.

Groundwater. To estimate the potential risks associated with completing a production well on the Base property, the upper 95th percent confidence limit of the arithmetic mean of the monitoring data for each COPCs was used as the value to represent the RME concentration. For samples with no detectable concentration of a chemical, a value of one-half the contract-required detection limit (CRDL) was used as recommended by EPA (1989a) guidance.

Table 5-7

Parameters Used to Estimate Exposure
Williams Air Force Base

Parameter	Range	Value Used	Rationale
Residential Exposure: Ingestion of Groundwater from New Wells			
Adult Water Ingestion Rate (L/day)	1.4 Average 2 90th Percentile	2	Standard exposure factor (EPA, 1991a)
Exposure Frequency (days/year)	350 Reasonable 365 Worst-Case	350	Parameter accounts for time spent away from home (EPA, 1991a)
Exposure Duration (years)	9 Average 30 90th Percentile	30	Upper 90th percentile for time spent in one residence (EPA, 1991a)
Body Weight (kg)		70	Standard exposure factor (EPA, 1989a)
Averaging Time for Noncarcinogenic Effects (days)		10,950	30 years x 365 days/years = 10,950 days (EPA, 1989a)
Averaging Time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)
Residential Exposure: Inhalation of Volatile Organic Compounds during Home Water Use (Water from New Wells)			
Adult Inhalation Rate (m^3/day)		15	Standard exposure factor for this pathway (EPA, 1991b)
Exposure Frequency (days/year)	350 Reasonable 365 Worst-Case	350	Parameter accounts for time spent away from home (EPA, 1991a)
Exposure Duration (years)	9 Average 30 90th Percentile	30	Upper 90th Percentile for time spent in one residence (EPA, 1991a)
Body Weight (kg)		70	Standard exposure factor (EPA, 1989a)
Averaging Time for Noncarcinogenic Effects (days)		10,950	30 years x 365 days/year = 10,950 days (EPA, 1989a)
Averaging time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)

Table 5-7

Parameters Used to Estimate Exposure
Williams Air Force Base

Parameter	Range	Value Used	Rationale
Residential Exposure: Dermal Contact with Chemicals in Water			
Skin Surface Area Available for Contact (cm^2)	19,400 - 50th Percentile (Adult Males) 16,900 - 50th Percentile (Adult Females)	18,150	The 50th percentile values for total skin surface area are cited as default factors for adults (EPA, 1992a). Male and female values were averaged.
Dermal Permeability Constant (cm/hr)		Chemical-specific values	Permeability values were obtained or derived as described by EPA, 1992a (See Table 6-1, OU-3 RI report)
Exposure Time (hours/day)	0.17 to 0.25	0.25	EPA, 1992a
Exposure Frequency (days/year)	350 Reasonable 365 Worst-Case	350	Parameter accounts for time spent away from home (EPA, 1991a)
Exposure Duration (years)	9 Average 30 90th Percentile	30	Upper 90th percentile for time spent in one residence (EPA, 1991a)
Adult Body Weight (kg)		70	Standard exposure factor (EPA, 1989a)
Averaging Time for Noncarcinogenic Effects (days)		10,950	30 years x 365 days/year = 10,950 days (EPA, 1989a)
Averaging Time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)
Residential Exposure: Incidental Ingestion of Soil (Juvenile)			
Juvenile Soil Ingestion Rate (mg/day)		200	Standard exposure factor for children 1 through 6 years old (EPA, 19-91a)
Fraction Ingested from Contaminated Source (unitless)		1	Represents the fraction of the ingestion rate that is attributable to the source. Since the residence is the source, it is assumed that 100% of the soils/dusts are from that area (EPA, 1989a)

Table 5-7

Parameters Used to Estimate Exposure
Williams Air Force Base

Parameter	Range	Value Used	Rationale
Exposure Frequency (days/year)	350 Reasonable 365 Worst-Case	350	Parameter accounts for time spent away from home (EPA, 1991a)
Exposure Duration (years)	Age-specific duration	6	Standard exposure factor to be used with age-specific factors throughout the calculation (EPA, 1991a)
Juvenile Body Weight (kg)		15	Average body weight for juveniles 1 through 6 years old (EPA, 1991a)
Averaging Time for Noncarcinogenic Effects (days)	Age-specific averaging times	2,190 (juvenile)	6 years x 365 days/year = 2,190 days for juveniles (EPA, 1989a)
Averaging Time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)
Residential Exposure: Dermal Contact with Soil (Juvenile)			
Exposed Surface Area (cm^2/event), Juvenile		1700	Assumes 15-year-old receptors expose their hands, forearms, feet, and lower legs to soil.
Soil-to-Skin Adherence Factors (mg/cm^2)	0.17 - 1.5	0.2	Average value (EPA, 1992)
Absorption Factor (unitless factor)		Chemical-specific	See Table 6-1, OU-3 RI report
Exposure Frequency (events/year)	350 Reasonable 365 Worst-Case	350	Parameter accounts for time spent away from home (EPA, 1991a)
Exposure Duration (years)	Age-specific duration	6	Standard exposure factor to be used with age-specific factors throughout the calculation (EPA, 1991a)
Juvenile Body Weight (kg)		15	Average body weight for juveniles 1 through 6 years old (EPA, 1991a)
Averaging Time for Noncarcinogenic Effects (days)		2,190 (juvenile)	6 years x 365 days/year = 2,190 days for juveniles (EPA, 1989a)
Averaging Time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)

Table 5-7

Parameters Used to Estimate Exposure
Williams Air Force Base

Parameter	Range	Value Used	Rationale
Residential Exposure: Inhalation of Volatiles/Fugitive Dusts (Adult)			
Adult Inhalation Rate (m^3/day)		20	Standard exposure factor (EPA, 1991a).
Exposure Frequency (days/year)	350 Reasonable 365 Worst-Case	350	Parameter accounts for time spent away from home (EPA, 1991a).
Exposure Duration (years)	9 Average 30 90th Percentile	30	Upper 90th percentile for time spent in one residence (EPA, 1991a).
Body Weight (kg)		70	Standard exposure factor (EPA, 1989a)
Averaging Time for Noncarcinogenic Effects (days)		10,950	30 years x 365 days/year = 10,950 days (EPA, 1989a)
Averaging Time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)
Occupational Exposure: Incidental Ingestion of Soil			
Adult Soil Ingestion Rate (mg/day)		50	Standard exposure factor (EPA, 1991a)
Exposure Frequency (days/year)		250	Assumes workers are exposed 5 days/week, 50 weeks/year (EPA, 1991a)
Exposure Duration (years)	25 years = the 95th Percentile	25	95th percentile (EPA, 1991a)
Body Weight (kg)		70	Standard exposure factor (EPA, 1989a)
Averaging Time for Noncarcinogenic Effects (days)		9125	25 years x 365 days/year = 9125 days (EPA, 1989a)
Averaging Time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)
Occupational Exposure: Inhalation of Volatiles/Fugitive Dusts			
Adult Inhalation Rate (m^3/day)		20	Standard exposure factor of 20 m^3/8-hour work day (EPA, 1991a)

Table 5-7

Parameters Used to Estimate Exposure
Williams Air Force Base

Parameter	Range	Value Used	Rationale
Exposure Frequency (days/year)		250	Assumes workers are exposed 5 days/week, 50 weeks/year (EPA, 1991a)
Exposure Duration (years)	25 years = the 95th Percentile	25	95th percentile (EPA, 1991a)
Body Weight (kg)		70	Standard exposure factor (EPA, 1989a)
Averaging Time for Noncarcinogenic Effects (days)		9125	25 years x 365 days/year = 9,125 days (EPA, 1989a)
Averaging Time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)
Occupational Exposure: Dermal Contact with Soil			
Exposed Surface Area (cm^2/event)		3100	Assumes workers expose arms and hands to soil (EPA, 1992a)
Soil to Skin Adherence Factor (mg/cm^2)	0.17 - 1.5	0.2	Average value (EPA, 1992a)
Absorption Factor (unitless)		Chemical-specific	See Table 6-1. OU-3 RI report
Exposure Frequency (events/year)		250	Assumes workers are exposed 5 days/week, 50 weeks/year (EPA, 1991a)
Exposure Duration (years)	25 years = 95th percentile	25	95th percentile (EPA, 1991a)
Body Weight (kg)		70	Standard exposure factor (EPA, 1989a)
Averaging Time for Noncarcinogenic Effects (days)		9125	25 years x 365 days/year = 9125 days (EPA, 1989a)
Averaging time for Carcinogenic Effects (days)		25,550	70 years x 365 days/year = 25,550 days (EPA, 1989a)

Table 5-8

Estimated Exposure-Point Concentrations for the Fire Protection Training Area No. 2 Williams Air Force Base

(Page 1 of 2)

Constituent	Exposure-Point Concentration Used	Rationale for Value Used
Dermal Contact and Ingestion - Groundwater		
Organics (µg/L)		Upper 95% confidence limit on the arithmetic mean from groundwater data. A value of one-half the detection limit was used in the statistical calculations for undetected data.
Acetone	4.3	
Carbon disulfide	6.4	
Methylene chloride	2.9	
Inorganics (µg/L)		
Lead	6.5	
Zinc	2500	
Inhalation of Volatiles From Groundwater		
Organics (mg/m^3)		Calculated from the upper 95% confidence limit on the arithmetic mean for groundwater data using a home water-use volatilization model.
Acetone	0.00215	
Carbon disulfide	0.0032	
Methylene chloride	0.00145	
Dermal Contact and Incidental Ingestion - Soil		
Organics (mg/kg)		Calculated from the upper 95% confidence limit on the arithmetic mean for soil data. A value of one-half the detection limit was used in the statistical calculations for undetected data.
1,2-Dichlorobenzene	4.03	
1,4-Dichlorobenzene	8.23	
Acetone	0.017	
Benzene	7.32	
Bis(2-ethylhexyl)phthalate	1.39	
Chloroform	0.66	
Ethyl benzene	6.64	
Methyl ethyl ketone	112	
Methylene chloride	3.04	
Toluene	9.41	
Xylenes	27.4	
Inorganics (mg/kg)		
Cadmium	4.6	
Chromium	16.4	
Copper	20	
Lead	18	
Mercury	7.0	
Nickel	18	
Zinc	62	

Table 5-8

Estimated Exposure-Point Concentrations for the Fire Protection Training Area No. 2 Williams Air Force Base

Constituent	Exposure-Point Concentration Used	Rationale for Value Used
Inhalation of Fugitive Dust		
Organics (mg/m^3)		Calculated from the upper 95% confidence limit on the arithmetic mean for soil data, using a dust loading model.
1,2-Dichlorobenzene	4.03×10^{-7}	
1,4-Dichlorobenzene	8.23×10^{-7}	
Acetone	1.70×10^{-9}	
Benzene	7.32×10^{-7}	
Bis(2-ethylhexyl)phthalate	1.39×10^{-7}	
Chloroform	6.60×10^{-8}	
Ethyl benzene	6.64×10^{-7}	
Methyl ethyl ketone	1.12×10^{-5}	
Methylene chloride	3.04×10^{-7}	
Toluene	9.41×10^{-6}	
Xylenes	2.74×10^{-6}	
Inorganics (mg/m^3)		
Cadmium	4.60×10^{-7}	
Chromium	1.64×10^{-6}	
Copper	2.00×10^{-6}	
Lead	1.80×10^{-6}	
Mercury	7.00×10^{-7}	
Nickel	1.80×10^{-6}	
Zinc	6.20×10^{-6}	
Inhalation of Volatiles from Soil		
Volatile Organics (mg/m^3)		Calculated from upper 95% confidence limit on the arithmetic mean for soil data using a subsurface soil volatilization model.
Acetone	2.44×10^{-5}	
Benzene	4.20×10^{-4}	
Chloroform	9.34×10^{-4}	
1,2-Dichlorobenzene	3.32×10^{-5}	
1,4-Dichlorobenzene	8.00×10^{-5}	
Ethyl benzene	3.18×10^{-4}	
Methyl ethyl ketone	4.96×10^{-2}	
Methylene chloride	8.48×10^{-3}	
Toluene	1.69×10^{-3}	
Xylenes	1.85×10^{-3}	

Table 5-9

Estimated Exposure-Point Concentrations for the Southwest Drainage System Williams Air Force Base

Constituent	Exposure-Point Concentration Used	Rationale for Value Used
Dermal Contact and Incidental Ingestion - Soil		
Organics (mg/kg)		Upper 95% confidence limit on the arithmetic mean for soil data. A value of one-half the CRDL was used in the statistical calculations for undetected data.
1,1,1-Trichloroethane	0.004[a]	
Acetone	0.083[a]	
Ethyl Alcohol	0.036[b]	
Methylene Chloride	0.06[a]	
Toluene	0.004[c]	
Bis(2-ethylhexyl)phthalate	3.64[b]	
Di-n-butyl phthalate	0.25[b]	
Diethyl phthalate	0.25[b]	
Phenol	0.38[a]	
Pyrene	0.27[b]	
Inorganics (mg/kg)		
Antimony	30.2[a]	
Arsenic	2.5[a]	
Beryllium	1.2[a]	
Cadmium	12.4[a]	
Chromium[d]	33.2[a]	
Copper	33.32[a]	
Lead	53.4[a]	
Mercury	0.11[a]	
Nickel	25.8[a]	
Selenium	0.68[a]	
Silver	2.5[a]	
Thallium	2.8[b]	
Zinc	152.5[a]	

Table 5-9

Estimated Exposure-Point Concentrations for the Southwest Drainage System Williams Air Force Base

Constituent	Exposure-Point Concentration Used	Rationale for Value Used
Inhalation of Fugitive Dust		
Organics (mg/m^3)		Calculated from the upper 95% confidence limit on the arithmetic mean interval for soil data using a dust loading factor of 6×10^{-4} g/m^3.
1,1,1-Trichloroethane	4.0×10^{-10}	
Acetone	8.3×10^{-9}	
Ethyl Alcohol	3.6×10^{-9}	
Methylene Chloride	6.0×10^{-9}	
Toluene	4.0×10^{-10}	
Bis(2-ethylhexyl)phthalate	3.6×10^{-7}	
Di-n-butyl phthalate	2.5×10^{-8}	
Diethyl phthalate	2.5×10^{-8}	
Phenol	3.8×10^{-8}	
Pyrene	2.7×10^{-8}	
Inorganics (mg/m^3)		
Antimony	3.0×10^{-6}	
Arsenic	2.5×10^{-7}	
Beryllium	1.2×10^{-7}	
Cadmium	1.2×10^{-6}	
Chromium[d]	3.3×10^{-6}	
Copper	3.3×10^{-6}	
Lead	5.3×10^{-6}	
Mercury	1.1×10^{-8}	
Nickel	2.6×10^{-6}	
Selenium	6.8×10^{-8}	
Silver	2.5×10^{-7}	
Thallium	2.8×10^{-7}	
Zinc	1.5×10^{-5}	

Table 5-9

Estimated Exposure-Point Concentrations for the Southwest Drainage System Williams Air Force Base

(Page 3 of 3)

Constituent	Exposure-Point Concentration Used	Rationale for Value Used
Inhalation of Volatiles from Soil		
Volatile Organics (mg/m^3)		Calculated from the upper 95% confidence limit on the arithmetic mean for soil data (samples from 0 to 1 foot) using a surface soil volatilization model.
1,1,1-Trichloroethane	0.00073	
Acetone	0.029	
Ethyl Alcohol	0.027	
Methylene Chloride	0.024	
Toluene	0.00022	

[a]Value for surface soil data summary.
[b]Value from combination surface and subsurface soil data summary.
[c]Value from subsurface soil data summary.
[d]Updated values, differing from values reported in Chapter 6 of OU-3 RI.

SD-09 has no groundwater sample data; therefore no exposure-point concentrations are calculated. Also, it was concluded that it would not be appropriate to use groundwater contaminant fate and transport models as a means for obtaining exposure-point concentrations for future land-use conditions (Section 6.3.3, OU-3 RI report). The primary reasons for excluding modeling were due to the arid conditions in Arizona, resulting in negligible precipitation driven chemical infiltration to the groundwater, and a detected decrease of COPC concentrations in the soil borings with increasing depths.

For the groundwater sample data at FT-02, the upper 95th percent confidence limit of the arithmetic mean of the current monitoring data was used as the future RME concentration. It was expected that future concentrations in groundwater would be less than those represented by the current exposure-point concentrations due to degradation and/or dilution during transport. The use of current data for the RME excludes both the potential for increased concentrations in the near future and decreased concentrations in the more distant future. This assumption of steady-state conditions should result in a health-protective estimate because exposure is not anticipated in the near future.

Indoor Air. The upper 95th percent confidence limit of the arithmetic mean of the groundwater monitoring data was used to estimate the potential concentration of VOCs during home use of groundwater. The concentrations of VOCs in air (milligrams per cubic meter [mg/m^3]) are estimated by multiplying their concentrations in water ($\mu g/L$) by the volatilization factor of 0.0005 $L\text{-}mg/\mu g\text{-}m^3$. Results are presented in Table 5-8.

Soil. FT-02 soil samples were analyzed from depths of 1 to 210 feet bgs. Because useable samples were taken from the surface (0 to 1 foot), soil data from the first 25 feet bgs were used in the risk assessment. Analytical results from the three surface soils samples, primarily to define the extent of surface soil contamination with PAHs, were included. The data did not indicate that the FT-02 surface soils were contaminated with PAHs.

SD-09 soil samples were analyzed from depths of 0 to 40.5 feet bgs. It was decided, due to the nature of the site and chemicals detected, to include data only to 25 feet bgs. Data from surface and subsurface soils were combined and, in most cases, the higher concentration (more conservative) value was chosen as the exposure point concentration.

RME concentrations were estimated as the upper 95th percent confidence limit of the arithmetic mean of the sampling data for each COPCs in each group. (For samples with no detectable concentration of a chemical, a value of one-half the CRDL was used.) RME will tend to overestimate exposure to surface soils, especially in the future, because concentrations are expected to decrease with time through weathering and volatilization.

Volatilization from Soils. Receptors in the site areas could potentially be exposed to vapor-phase chemicals due to volatilization of organic compounds present in the surface or subsurface soils. Volatilization and dispersion models were used to estimate air concentrations of VOCs based on their concentrations in soil. First, a VOC flux from soil was calculated, then air dispersion was modeled for on-site receptors. Model assumptions and parameters are presented in great detail in Section 6.3.3 of the OU-3 RI report. The upper 95th percent confidence limit of the arithmetic mean of the soil data was used to estimate the potential concentration of chemicals in the air because of volatilization.

Air Dispersion Model. Dispersion of volatiles into air was estimated using the Near Field Box Model, which calculates the ambient air concentration based on the assumption that the volatiles are uniformly distributed in a hypothetical box, of finite height, downwind from the site.

Fugitive Dust. Estimating airborne concentrations of chemicals in the particulate phase involves modeling resuspension and dispersion. Resuspension of hazardous chemicals were estimated using a simple dust loading equation (DOE, 1989). This method is useful for estimating exposure concentrations of chemicals in air for construction workers or those involved in remediation activities at the contaminant release point.

5.3.4 Uncertainties

There are several sources of uncertainty in the exposure assessment process that may ultimately impact the risk assessment. These sources can be generally categorized as: current and future land-use assumptions, media sampling and analysis, evaluation of exposure pathways, and exposure parameter values.

5.4 Toxicity Assessment

5.4.1 Contaminant Toxicity

The toxicity assessment provides information regarding the type and severity of adverse health effects that could result from exposure to COPCs and a measure of the dose-response relationship for each chemical. These dose-response relationships for oral, inhalation, and dermal toxicity are expressed quantitatively as reference doses (RfD) and slope factors (SF), which have been derived by the EPA. The sources of these values are the Integrated Risk Information System (IRIS) (EPA, 1994a) and the Health Effects Assessment Summary Tables (HEAST) (EPA, 1993), unless otherwise stated. This information is summarized in Tables 5-10 and 5-11.

Slope factors, derived by the EPA, expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in units of mg/kg-day, to provide an upper bound estimate of excess lifetime cancer risks associated with exposure at that intake level. The term "upper-bound" reflects the conservative estimate of risks calculated from the SF.

RfDs have been developed by the EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, expressed in units of mg/kg-day, are estimates of an average lifetime exposure levels for humans, including sensitive individuals, not expected to result in adverse effects. Estimated intakes of chemicals are compared to RfDs because exposure to a chemical above this average intake level is a potential cause for an adverse health effect.

5.4.2 Dermal Toxicity Values

Dermal RfD values and SFs (Table 5-12) are derived from the corresponding oral values, provided there is no evidence to suggest that dermal exposure induces exposure route-specific effects that are not appropriately modeled by oral exposure data. In the derivation of a dermal RfD, the oral RfD is multiplied by the gastrointestinal absorption factor (GAF), expressed as a decimal fraction. The resulting dermal RfD, therefore, is based on absorbed dose. The RfD based on absorbed dose is the appropriate value with which to compare a dermal dose, because dermal doses are expressed as absorbed rather than exposure or contact doses. The dermal SF is derived by dividing the oral SF by the GAF. The oral SF is divided, rather than multiplied, by the GAF because SFs are expressed as reciprocal dose.

5.5 Risk Characterization

This section provides a characterization of the potential health risks associated with the intake of chemicals at OU-3. The methods for estimating risk from carcinogenic and noncarcinogenic COPCs are presented in this section, followed by a qualitative discussion of risks from COCs with no available toxicity data. The results of the risk assessment are presented for FT-02 and SD-09, followed by a discussion of uncertainties in risk characterization.

Table 5-10

Summary of Slope Factors Williams Air Force Base

Constituent	Oral Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$	Weight of Evidence	Type of Cancer	Inhalation Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$	Weight of Evidence	Type of Cancer
Acetone	NA	D	NA	NA	D	NA
Antimony	NE	NE	NE	NE	NE	NE
Arsenic	1.8	A	Skin	15[a]	A	Lung
Benzene	2.90×10^{-2}	A	Leukemia	2.90×10^{-2}[b]	A	Leukemia
Beryllium	4.30	B2	Total tumors	8.40[b]	B2	Lung
Bis(2-ethylhexyl)phthalate	1.40×10^{-2}	B2	Liver	NL	B2	NL
Cadmium	NL	NL	NL	6.30[a]	B1	Respiratory tract
Carbon disulfide	NE	NE	NE	NE	NE	NE
Chloroform	6.10×10^{-3}	B2	Kidney	8.10×10^{-2}[b]	B2	Liver
Chromium	NL	NL	NL	4.10×10^{1}[b]	A	Lung
Copper	NA	D	NA	NA	D	NA
1,2-Dichlorobenzene	NA	D	NA	NA	D	NA
1,4-Dichlorobenzene	2.40×10^{-2}[b]	C	Liver	NL	C	NL
Diethyl phthalate	NA	D	NA	NA	D	NA
Di-n-butyl phthalate	NA	D	NA	NA	D	NA
Ethyl alcohol	NE	NE	NE	NE	NE	NE
Ethyl benzene	NA	D	NA	NA	D	NA
Lead	NL	B2	NL	NL	B2	NL

Table 5-10

Summary of Slope Factors
Williams Air Force Base

(Page 2 of 2)

Constituent	Oral Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$	Weight of Evidence	Type of Cancer	Inhalation Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$	Weight of Evidence	Type of Cancer
Mercury	NA	D	NA	NA	D	NA
Methyl ethyl ketone	NA	D	NA	NA	D	NA
Methylene chloride	7.50×10^{-3}	B2	Liver	1.65×10^{-3}[a]	B2	Lung, liver
Nickel	NL	NL	NL	8.4×10^{-1}[b]	A	Respiratory tract
Phenol	NA	D	NA	NA	D	NA
Pyrene	NA	D	NA	NA	D	NA
Selenium	NA	D	NA	NA	D	NA
Silver	NA	D	NA	NA	D	NA
Thallium compounds	NA	D	NA	NA	D	NA
Toluene	NA	D	NA	NA	D	NA
1,1,1-Trichloroethane	NA	D	NA	NA	D	NA
Xylenes	NA	D	NA	NA	D	NA
Zinc	NA	D	NA	NA	D	NA

[a]Value converted from unit risk estimate to slope factor using conversion method in Health Effects Assessment Summary Tables (HEAST) (EPA, 1993).
[b]Values obtained from HEAST.

NA - Not applicable.
NE - Chemical has not been evaluated for carcinogenicity.
NL - Not listed.
The source of the toxicity values is the Integrated Risk Information System (IRIS) (EPA, 1994a) unless otherwise indicated in the footnotes.

Table 5-11

Summary of Reference Doses
Williams Air Force Base

Constituent	Oral Reference Dose (RfD) (mg/kg-day)	Target Organ	Uncertainty Factor	Inhalation Reference Dose (RfD) (mg/kg-day)	Target Organ	Uncertainty Factor
Acetone	1.00×10^{-1}	Kidney	1000	NL	NL	NL
Antimony	4.00×10^{-4}	Cardiovascular system	1000	NL	NL	NL
Arsenic	3.00×10^{-4}	Skin	3	NL	NL	NL
Benzene	NL	NL	NL	NL	NL	NL
Beryllium	5.00×10^{-3}[a]	ND	100	NL	NL	NL
Bis(2-ethylhexyl)phthalate	2.00×10^{-2}	Liver	1000	NL	NL	NL
Cadmium	5.00×10^{-4} (water)	Kidney	10	NL	NL	NL
Cadmium	1.00×10^{-3} (food)	Kidney	10	NL	NL	NL
Carbon disulfide	1.00×10^{-1}	Fetus	100	2.90×10^{-3}[b,c]	Fetus	1000
Chloroform	1.00×10^{-2}	Liver	1000	NL	NL	NL
Chromium VI	5.00×10^{-3}	ND	500	NL	NL	NL
Copper	NL[d]	Local gastrointestinal irritation	NL	NL	NL	NL
1,2-Dichlorobenzene	9.00×10^{-2}	Liver	1000	4.00×10^{-2}[b]	ND	1000
1,4-Dichlorobenzene	NL	NL	NL	2.39×10^{-1}[b,c]	Liver	100
Diethyl phthalate	8.00×10^{-1}	ND	1000	NL	NL	NL

Table 5-11

Summary of Reference Doses
Williams Air Force Base

(Page 2 of 3)

Constituent	Oral Reference Dose (RfD) (mg/kg-day)	Target Organ	Uncertainty Factor	Inhalation Reference Dose (RfD) (mg/kg-day)	Target Organ	Uncertainty Factor
Di-n-butyl phthalate	1.00×10^{-1}	ND	1000	NL	NL	NL
Ethyl alcohol	NL	NL	NL	NL	NL	NL
Ethyl benzene	1.00×10^{-1}	Liver	1000	2.86×10^{-1c}	Fetus	300
Lead	NL	NL	NL	NL	NL	NL
Mercury	3.00×10^{-4b}	Kidney	1000	$8.6 \times 10^{-5b,c}$	Nervous system	30
Methyl ethyl ketone	6.00×10^{-1}	Fetus	3000	2.9×10^{-1}	Fetus	3000
Methylene chloride	6.00×10^{-2}	Liver	100	8.60×10^{-1c}	Liver	100
Nickel	2.00×10^{-2b}	ND	300	NL	NL	NL
Phenol	6.00×10^{-1}	Fetus	100	NL	NL	NL
Pyrene	3.00×10^{-2}	Kidney	3000	NL	NL	NL
Selenium	5.00×10^{-3}	Skin	3	NL	NL	NL
Silver	5.00×10^{-3}	Skin	3	NL	NL	NL
Thallium	6×10^{-5e}	Skin	3000	NL	NL	NL
Toluene	2.00×10^{-1}	Liver	1000	1.10×10^{-1c}	Nervous system	30
1,1,1-Trichloroethane	9.0×10^{-2f}	Liver	1000	3.0×10^{-1f}	Liver	1000

Table 5-11

Summary of Reference Doses
Williams Air Force Base

(Page 3 of 3)

Constituent	Oral Reference Dose (RfD) (mg/kg-day)	Target Organ	Uncertainty Factor	Inhalation Reference Dose (RfD) (mg/kg-day)	Target Organ	Uncertainty Factor
Xylenes	2.00	Nervous system	100	NL	NL	NL
Zinc	3.00×10^{-1}	Blood	3	NL	NL	NL

ND - Not determined.
NL - Not listed.
UF - Uncertainty factor.

The source of the toxicity values is the Integrated Risk Information System (IRIS) (EPA, 1994b) unless otherwise indicated in the footnotes.

[a]Value based upon soluble salts of beryllium.
[b]Value obtained from the Health Effects Assessment Summary Tables (HEAST) (EPA, 1993).
[c]Value converted from reference concentration (RfC) to inhalation RfD according to method in HEAST.
[d]An RfD was not estimated from the drinking water standard for copper of 1.3 mg/L because the drinking water standard is based on acute effects and an RfD derived therefrom may not be protective for chronic effects.
[e]Derived by analogy to thallium sulfate by adjusting for differences in molecular weight.
[f]Taken from 1992 HEAST (U.S. EPA, 1992b).

Table 5-12

Summary of Dermal Reference Doses and Dermal Cancer Slope Factors Williams Air Force Base

(Page 1 of 2)

Constituent	GAF[a]	Dermal Reference Dose (RfD) (mg/kg-day)[b]	Dermal Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$[c]
Acetone	0.83[d]	8.3×10^{-2}	ND
Antimony	0.05[e]	2.0×10^{-5}	ND
Arsenic	0.95[d]	2.9×10^{-4}	1.9
Benzene	1.0[f]	ND	2.9×10^{-2}
Beryllium	0.01[d]	5.0×10^{-5}	430
Bis(2-ethylhexyl)phthalate	0.9[g]	1.8×10^{-2}	1.6×10^{-2}
Cadmium	0.05[d]	2.5×10^{-5}	ND
Carbon Disulfide	0.9[g]	9.0×10^{-2}	ND
Chloroform	1.0[f]	1.0×10^{-2}	6.1×10^{-3}
Chromium	0.05[f]	2.5×10^{-4}	ND
Copper	0.6[d]	ND	ND
1,2-Dichlorobenzene	0.9[g]	8.1×10^{-2}	ND
1,4-Dichlorobenzene	0.9[g]	ND	2.7×10^{-2}
Diethyl phthalate	0.9[g]	7.2×10^{-1}	ND
Di-n-butyl phthalate	0.85[f]	8.5×10^{-2}	ND
Ethyl alcohol	0.9[g]	ND	ND
Ethyl benzene	0.9[f]	9.0×10^{-2}	ND
Lead	0.1[f]	ND	ND
Mercury	0.15[d]	4.5×10^{-5}	ND
Methyl ethyl ketone	0.95[d]	5.7×10^{-1}	ND
Methylene chloride	1.0[f]	6.0×10^{-2}	7.5×10^{-3}
Nickel	0.1[d]	2.0×10^{-3}	ND
Phenol	0.9[g]	5.4×10^{-1}	ND
Pyrene	0.9[g]	2.7×10^{-2}	ND

Table 5-12

Summary of Dermal Reference Doses and Dermal Cancer Slope Factors Williams Air Force Base

(Page 2 of 2)

Constituent	GAF[a]	Dermal Reference Dose (RfD) (mg/kg-day)[b]	Dermal Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$[c]
Selenium	0.6[f]	3.0×10^{-3}	ND
Silver	NA[h]	ND	ND
Thallium	0.05[g]	3×10^{-6}	ND
Toluene	1.0[d]	2.0×10^{-1}	ND
1,1,1-Trichloroethane	0.9[g]	8.1×10^{-2}	ND
Xylenes	0.9[d]	1.8×10^{0}	ND
Zinc	0.25[d]	7.5×10^{-2}	ND

[a]GAF = Gastrointestinal absorption factor.
[b]Dermal RfD is derived by multiplying the oral RfD by the GAF (Section 5.4.2).
[c]Dermal SF is derived by dividing the oral SF by the GAF (Section 5.4.2).
[d]EPA, 1993b.
[e]Default value: metals tend to be poorly absorbed by the gastrointestinal tract (EPA, 1989a).
[f]Jones and Owen, 1989.
[g]Default (Section 6.4.3, OU-3 RI report).
[h]Dermal contact with silver induces local skin discoloration, and oral exposure to silver induces silver accumulation in internal organs; therefore, oral exposure is not an acceptable model for dermal exposure, and dermal toxicity values are not derived from oral toxicity values.

ND = Not derived.
NA = Not applicable.

5.5.1 Carcinogens

ILCR were estimated for each chemical. ILCR is expressed in terms of additional cancers that might be anticipated as a result of specific exposure to an external influence. Thus, a 10^{-6} ILCR indicates that one additional person in one million is likely to develop some form of cancer or that an exposed individual has an additional one-in-one-million chance of developing cancer. ILCR is estimated by multiplying a chemical's SF, in $(mg/kg\text{-}day)^{-1}$, by its intake value, in mg/kg-day (EPA, 1989a).

In evaluating acceptable residential exposures to potentially carcinogenic compounds, the EPA recommends the use of an acceptable risk range of 10^{-4} to 10^{-6} for CERCLA sites (EPA, 1990a). EPA also uses an incremental lifetime risk level of one in one million as the bottom of the acceptable range for developing drinking water standards (EPA, 1987). The maximum acceptable ILCR recommended by the EPA for drinking water is 10^{-4} (EPA, 1987).

5.5.2 Noncarcinogens

Chemicals that produce health effects other than cancer were evaluated in terms of their relative hazard when compared to acceptable exposure levels. The hazard quotient (HQ), used to quantify noncancer health hazards, for exposure to noncarcinogens is the ratio of the estimated daily intake to the RfD for that chemical (EPA, 1989a). The HQ does not address intake-response relationships and its numerical value should not be construed to be a probabilistic estimate of risk. It is a numerical proximity to acceptable limits of exposure or the degree to which acceptable exposure levels are exceeded. If this index exceeds unity, concern for the potential hazard of the chemical increases. Exceeding unity does not in itself imply a potential hazard; however, it does suggest that a given situation should be more closely scrutinized.

The sum of all hazard quotients for a given pathway or medium is the hazard index (HI). EPA (1989a) advocates the use of total HI for a mixture of components based on the assumption of response additivity. Summation of the individual HQs could result in an HI that exceeds 1, even if no single chemical exceeds its acceptable level. Mechanistically, it is not appropriate to sum HQs unless the chemicals that compose the mixture have similar modes of action on the identical organ. Consequently, the summing of HQs for a mixture of compounds that are not expected to induce the same type of effects could overestimate the potential risk. The EPA recommends that if the total HI is greater than unity, the components of the mixture should be grouped by critical effect (target organ) and separate HIs should be derived for each effect. Critical effects are described in the HEAST and in IRIS (EPA, 1993, 1994a) and are summarized in Table 5-11.

5.5.3 Chemicals with No Published Toxicity Values

Copper. EPA (1993) notes that the current drinking water standard for copper is 1.3 mg/L. The data, however, based on gastroenteritis arising from acute exposure, are not sufficient for derivation of an oral RfD. Copper was not detected in FT-02 groundwater. The 95 percent upper confidence level on the mean concentrations in FT-02 soils (20 mg/kg), SD-09 surface soils (50 mg/kg) and SD-09 subsurface soils (19 mg/kg), although above the Base-specific background concentration (<5 mg/kg), were within or below the regional background concentration range (30 to 50 mg/kg), and were also below the EPA Region IX PRG for residential soil of 2900 mg/kg (EPA, 1994b), and are not expected to induce adverse effects.

Ethyl Alcohol. In the absence of toxicity values, the potential toxicity of ethyl alcohol was evaluated qualitatively. Ethyl alcohol was detected in one out of 31 surface soil samples and in five of 32 subsurface soil samples from SD-09. The 95 percent upper confidence level on the mean concentration was 0.033 mg/kg in surface soil and 0.042 mg/kg in subsurface soil. The exposure pathways that were investigated for SD-09 include: incidental ingestion of soils, dermal contact with soil, inhalation of volatiles from soils, and inhalation of fugitive dusts. Given the frequency of samples in which alcohol was detected and the relatively low soil concentrations, the effects of ethyl alcohol associated with the SD-09 surface soils are expected to be negligible.

Lead. There are no oral RfD or inhalation RfC/RfD values for lead, primarily because effects may occur at doses so low as to appear to be without thresholds, and because lead is ubiquitous in all environmental media so that the contribution to total body intake from one exposure pathway (e.g., ingestion of contaminated soil) cannot be quantified (EPA, 1990b; 1994b).

Version 99D of the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) (EPA, 1994c) was used to evaluate lead in drinking water and soil for FT-02, and lead in soil for SD-09, although the latest EPA guidance (1994d) does not recommend further evaluation if soil lead levels are below 400 mg/kg. The IEUBK integrates lead uptake from inhalation, drinking water, diet, soil and dust ingestion, and ingestion of incidental sources such as chips of lead-based paint, and estimates blood lead concentrations over the first 7 years of a child's life. The IEUBK was run for FT-02 groundwater and SD-09 soils.

In all cases, modeled blood lead concentrations were less than or equal to 10 micrograms per deciliter (µg/dL) for 95 percent of hypothetically exposed children (i.e., that blood lead concentrations exceeded 10 µg/dL for less than 5 percent of hypothetically exposed children, which conforms to the latest [EPA, 1994d] guidance on lead in soil).

Characterization of health hazards due to lead is discussed in greater detail in section 6.5.3 of the OU-1 RI.

5.5.4 Results of Risk Characterization

When the FT-02 risk assessment was first performed and published as part of the OU-1 RI report, the Base was operating. Since then, the Base-specific background range for inorganics has been established and the Base has closed. This report presents the addition of five inorganic chemicals (chromium, copper, lead, nickel, and zinc) to the original list of COCs in soil because of the Base-specific background results. The SD-09 risk assessment, however, represents a more complete update incorporating additional soil analytical data. In addition, all default exposure parameter values and toxicity values used in the original risk assessment were evaluated and updated in this version. Also, the newer (EPA, 1992) dermal exposure assessment guidance was used to quantify uptake of chemicals from dermal exposure to water, and the EPA (1991b) model for inhalation of volatiles from household water was used.

Risk results are summarized in Tables 5-13 and 5-14 and are computed to three significant figures. In the text, however, risk results are expressed as two significant figures to more realistically reflect the uncertainty inherent in risk calculations.

Fire Protection Training Area No. 2. Risk characterization results for FT-02 are summarized in Table 5-13.

The current occupational scenario was evaluated for exposure to soil by the pathways presented in Table 5-13. No pathway had an HI exceeding 1, or an ILCR exceeding the target range of 10^{-6} to 10^{-4}. The total receptor HI, 5.7×10^{-2}, was well below 1. The total receptor ILCR, 2.0×10^{-5}, was within the target range of 10^{-6} to 10^{-4}.

Table 5-13

Summary of Risk Characterization Results
Fire Protection Training Area No. 2
Williams Air Force Base

Exposure Pathway	Total Hazard Index	Primary Contributor(s)	Total ILCR	Primary Contributor(s)
Current Occupational Scenario - Soil				
Ingestion of Soil	1.61×10^{-2}	Mercury, Cadmium, Chromium	7.97×10^{-8}	Benzene
Dermal Contact with Soil	4.51×10^{-4}	Ethyl benzene, Chloroform	1.62×10^{-7}	1,4-Dichlorobenzene
Inhalation of Volatiles from Soil	3.89×10^{-2}	Methy ethyl ketone	1.48×10^{-5}	Benzene chloroform
Inhalation of Fugitive Dust from Soil	1.61×10^{-3}	Mercury	5.01×10^{-6}	Chromium
Total Occupational HI or ILCR:	5.70×10^{-2}		2.01×10^{-5}	
Future Residential Scenario - Groundwater				
Ingestion of Groundwater	2.33×10^{-1}	Zinc	2.55×10^{-7}	Methylene chloride
Dermal Contact with Groundwater	3.50×10^{-4}	Carbon disulfide	7.76×10^{-9}	Methylene chloride
Inhalation of Volatiles from Groundwater	2.27×10^{-1}	Carbon disulfide	2.11×10^{-7}	Methylene chloride
Total Groundwater HI or ILCR:	4.60×10^{-1}		4.74×10^{-7}	
Future Residential Scenario - Soil				
Ingestion of Soil	4.20×10^{-1}	Mercury	5.00×10^{-7}	Benzene
Dermal Contact with Soil	1.62×10^{-3}	Ethyl benzene	1.40×10^{-7}	1,4-Dichlorobenzene
Inhalation of Volatiles from Soil	5.44×10^{-2}	Methyl ethyl ketone	2.48×10^{-5}	Benzene
Inhalation of Fugitive Dust from Soil	2.25×10^{-3}	Mercury	8.42×10^{-6}	Chromium
Total Soil HI or ILCR:	4.80×10^{-1}		3.40×10^{-5}	
Total Residential HI or ILCR:	9.40×10^{-1}		3.40×10^{-5}	

Table 5-14

Summary of Risk Characterization Results
Southwest Drainage System
Williams Air Force Base

Exposure Pathway	Total Hazard Index	Primary Contributor(s)	Total ILCR	Primary Contributor(s)
Current Occupational Scenario - Soil				
Ingestion of Soil	7.48×10^{-2}	Antimony, Thallium	1.70×10^{-6}	Beryllium, Arsenic
Dermal Contact with Soil	3.53×10^{-5}	Pyrene	7.97×10^{-10}	Bis(2-ethylhexyl)phthalate, Methylene chloride
Inhalation of Volatiles from Soil	6.33×10^{-3}	Methylene chloride	2.77×10^{-6}	Methylene chloride
Inhalation of Fugitive Dust from Soil	2.50×10^{-5}	Mercury	1.05×10^{-5}	Chromium
Total Occupational HI or ILCR:	8.12×10^{-2}		1.50×10^{-5}	
Current and Future Residential Scenario - Soil				
Ingestion of Soil	$1.95 \times 10^{+0}$[a]	Antimony, Thallium, Chromium, Cadmium, Arsenic	1.06×10^{-5}	Beryllium, Arsenic
Dermal Contact with Soil	1.26×10^{-4}	Pyrene	6.86×10^{-10}	Bis(2-ethylhexyl)phthalate, Methylene chloride
Inhalation of Volatiles from Soil	8.86×10^{-3}	Methylene chloride	4.65×10^{-6}	Methylene chloride
Inhalation of Fugitive Dust from Soil	3.50×10^{-5}	Mercury	1.76×10^{-5}	Chromium
Total Residential HI or ILCR:	$1.96 \times 10^{+0}$[a]		3.29×10^{-5}	

[a]This HI, although it exceeds 1.0, does not represent unacceptable intakes, as explained in Section 5.5.4.

The future residential scenario was evaluated for exposure to groundwater and soil by the pathways presented in Table 5-13. No pathway had an HI exceeding 1, or an ILCR exceeding the target range of 10^{-6} to 10^{-4}. The total ILCR for the future residential scenario, 3.4×10^{-5}, was within the target range of 10^{-6} to 10^{-4}. The total HI for this receptor was 9.4×10^{-1}.

Southwest Drainage System. Risk characterization results for SD-09 are summarized in Table 5-14. HI and ILCR values in Table 5-14 were computed to reflect the most recent chromium data, as was noted in Section 5.2.2.2, and, therefore differ marginally from results presented in the OU-3 RI report.

For the current occupational scenario, the total receptor HI was 8.1×10^{-2}, suggesting that there is little concern regarding adverse noncancer effects. The total ILCR is 1.5×10^{-5}, within the target risk range of 10^{-6} to 10^{-4}.

For the current and future residential scenarios, the total receptor HI was 1.9, due primarily to antimony (50 percent of total receptor HI). The only significant pathway of concern was incidental soil ingestion by the resident child. Base subsurface soil sampling results after 1989 have not shown high concentrations of antimony (Chapter 4.0, OU-3 RI report), and it was concluded that the unusually high source-term concentration of antimony used in this evaluation was due to laboratory error. The remainder of the HI for incidental ingestion of soil is due primarily to arsenic, cadmium, chromium, and thallium.

The evaluation of incidental ingestion of soil for SD-09 can be limited to arsenic, cadmium, chromium, and thallium because together these metals contribute 97 percent of the remaining HI (i.e., the total HI minus that due to antimony). The skin is the target organ for arsenic and thallium; therefore, the HI for the skin is the sum of the HI values for arsenic and thallium. The target organ for chromium has not been determined. The target organ for cadmium is the kidney. None of the target organ HI values exceed 1, suggesting that the total HI for the current and future residential receptor in Table 5-14 was overly conservative.

The total ILCR for the current and future residential scenario for SD-09 was 3.3×10^{-5}, within the target risk range of 10^{-6} to 10^{-4}.

5.5.5 Vegetable Ingestion Pathway

Terrestrial uptake of contaminants into vegetables is dependent on the mobility and persistence of contaminants and the type of vegetation. Any contaminant with a significant biotransfer factor could pose a greater risk through the terrestrial food chain pathway than through the direct soil ingestion pathway, primarily because the ingestion rate of homegrown vegetables is roughly 500 to 1,000 times higher than the rate of incidental soil ingestion. Exposure through the food chain would also be higher than exposures through dermal contact with soil and through inhalation of fugitive dust, primarily because the contaminant intake is significantly less through these pathways.

Homegrown fruit and vegetable ingestion may significantly increase the risk from exposure to mercury for the future resident exposed to FT-02. Analysis for SD-09 raises concern regarding the uptake of arsenic and cadmium by homegrown fruits and vegetables. The following table by Sauerback (1988) provides a qualitative guide for assessing heavy metal uptake into a number of plants (EPA, 1991a).

Plant Uptake of Heavy Metals			
High	Moderate	Low	Very Low
Lettuce Spinach Carrot Endive Cress Beet and beet leaves	Onion Mustard Potato Radish	Corn Cauliflower Asparagus Celery Berries	Beans Peas Melon Tomatoes Fruit

5.5.6 Uncertainties

A risk assessment of a site is ultimately an integrated evaluation of historical, chemical, analytical, environmental, demographic, and toxicological data that are as site-specific as possible. Uncertainty plays a major role in the final results of a risk assessment and exists at every stage of the risk assessment. Following is a list of some of the primary sources of uncertainty in a risk assessment:

- Source-term concentrations, due to variations in the sample analytical results
- Input values for exposure assessment models

- Accuracy with which the models themselves represent environmental processes
- High-to-low dose and interspecies extrapolations for dose response relationships.

It is not possible to eliminate all uncertainty; thus, to minimize the possibility of underestimating risk, each step is biased toward health-protective estimations. For example, using the 95 percent upper confidence limit of the average contaminant concentrations in the risk calculations is done purposely so that risk will be over- rather than underestimated. The 95 percent upper confidence limit on the mean concentration was used even when it exceeded the maximum detected concentration. Newer EPA guidance indicates that the maximum detected concentration could have been used in these cases, because little confidence can be placed in an upper confidence limit that exceeds the maximum detected concentration.

Similarly, the RME scenario uses upper-bound values for environmental medium contact rates (e.g., soil ingestion, air inhalation, and dermal contact rates), exposure frequency and exposure duration, ensuring risk estimates that are biased toward conservatism.

The toxicity values are also biased toward conservatism. Worst-case assumptions are used regarding human sensitivity and the adversity of observed effects in the derivation of RfDs for noncancer effects. The SFs for cancer reflect an upper limit on the dose-effect relationship, resulting in an upper-bound estimate on risk.

Additional conservatism accompanies the nature of contamination observed at each of the individual sites. The cancer risk at FT-02, for example, is "driven" largely by a few VOCs and chromium. However, the VOC concentrations will decrease with time due to volatilization and biodegradation, so that cancer risk will also decrease with time. The chromium risk was calculated assuming that all the chromium was present in the hexavalent (carcinogenic) state, although it is well established that hexavalent chromium in the environment tends to be reduced to the trivalent (noncarcinogenic) state.

SD-09 cancer risks are driven by arsenic, beryllium, chromium, and methylene chloride. As previously discussed, chromium was assumed to be present entirely in the hexavalent state, although this is very unlikely and exaggerates the estimated risk. Also, concentrations of methylene chloride will decrease with time due to volatilization and biodegradation. Although arsenic and beryllium are major contributors to total cancer risk, their upper confidence limits are within the range of Base-specific background, i.e., the cancer risk from exposure to these naturally-occurring metals at some uncontaminated off-site location would be similar to the risks from exposure to SD-09.

Because each step builds on the previous one, this biased approach mathematically compounds, and should more than compensate for, risk assessment uncertainties. In addition, these calculations do not represent currently existing or expected future exposure or health risks. Rather, they are estimates of potential risk only if all of the conservative exposure assumptions are realized.

This qualitative discussion of uncertainty is not intended to discredit the calculated results, but to point out that risks are calculated for a hypothetical scenario under well defined constraints. Recognition of uncertainties is fundamental to the proper use of these results in guiding remedial action decision making.

5.6 Ecological Assessment

At FT-02, adverse effects are highly unlikely due to a lack of ecological receptors. Direct mechanical stress has eliminated all habitats and community structure, leading to a lack of ecological receptors at this study site. Small mammal or terrestrial arthropod species could come into contact with contaminated FT-02 soils as they transit the area, but frequency of exposure under these circumstances is presumed to be low. There is no suitable habitat at FT-02 to encourage actual occupation of the study site by these species.

At SD-09, periodic, ongoing maintenance mowing holds the channel alignment and lagoon basin in a permanent state of arrested secondary succession. Invertebrate and mammalian receptors extant in communities that have formed despite these chronic disruptions could have experienced, or could be experiencing, acute or chronic toxic effects due to the presence of the constituents detected in soils or surface waters at SD-09. For additional details concerning the findings of the baseline ecological risk assessment, consult the final report (IT, 1993d).

5.7 Remedial Action Decision Summary for OU-3

During the FS, PRGs were determined for chemicals in soil and groundwater at each OU-3 site. The PRGs for soil at sites FT-02 and SD-09 were established by considering base-specific background concentrations, EPA Region IX PRGs, and Arizona HBGLs for soil. Background concentration ranges for each chemical in soil were determined from surface soil sampling at areas of the Base away from known or suspected contamination. The EPA

Region IX PRGs are health-based concentrations that correspond to either a one in one million (10^{-6}) cancer risk or a chronic noncancer HQ of one, whichever is lower. Because the ultimate land use of the OU-3 sites is unknown, the EPA Region IX PRGs selected for use were based on a residential land-use scenario. This land-use scenario provides for the most health-protective PRGs.

PRGs for groundwater at FT-02 were established by considering base-specific background concentrations, federal and state primary and secondary drinking water standards. EPA Region IX PRGs, and Arizona HBGLs.

After PRGs were determined for chemicals in the applicable environmental media at the OU-3 sites, an analysis was performed to determine if these chemicals were present at concentrations requiring remedial action. This evaluation involved comparing the upper confidence limit (UCL) concentration of each chemical in soil and groundwater to its respective PRG. Those chemicals with UCL concentrations exceeding the PRG were determined to be COCs requiring remedial action. The PRGs for compounds determined to be COCs are enforceable cleanup levels under this ROD.

A more detailed description of the process used to establish PRGs and identify COCs requiring remedial action is presented in the Chapter 2.0 of the OU-3 FS report. Tables summarizing the determination of COCs and their respective cleanup levels in soil and groundwater for FT-02 and SD-09 are presented in Appendix A.

Sections 5.7.1 and 5.7.2 discuss the remedial action objectives (RAO), COCs, and cleanup levels for soil and groundwater at FT-02 and SD-09. A summary of RAOs for OU-3 is presented in Appendix A, Table A-4.

5.7.1 Fire Protection Training Area No. 2

5.7.1.1 Soil

Remedial action will be required for FT-02 soil. Three organic compounds (benzene, chloroform, and 1,4-dichlorobenzene) were determined to be COCs for FT-02 soil because the UCL concentration of each compound was greater than its respective PRG. Benzene, chloroform, and 1,4-dichlorobenzene were detected in FT-02 soil at UCL concentrations of 7.3, 0.66, and 8.2 mg/kg, respectively. Benzene and chloroform are both VOCs. Benzene is known to cause cancer in humans, and chloroform is categorized as a probable human carcinogen based on data from animal studies. 1,4-dichlorobenzene is an SVOC that is categorized as a possible human carcinogen based on limited evidence of carcinogenicity in animals. Based on the risk-based analyses presented in the OU-3 RI/FS documents, the following RAOs was established for FT-02 soil:

- Protect human health and the environment by reducing the concentration of benzene, chloroform, and 1,4-dichlorobenzene in FT-02 soils to 1.4, 0.53, and 7.4 mg/kg, respectively. The residual total ILCR for all chemicals in soil summed across all exposure pathways will be within the acceptable risk range of 10^{-6} to 10^{-4}. The reduction in organic contaminants will prevent the future migration of contaminants to groundwater.

The concentrations listed in the RAO for each COCs are cleanup levels enforceable under the ROD.

Actual or threatened releases of hazardous substances from this site, if not addressed by the preferred alternative or one of the other active measures considered, may present a current or potential threat to public health, welfare, or the environment.

5.7.1.2 Groundwater

Remedial action is not required for FT-02 groundwater because the UCL concentration of all chemicals detected in groundwater were below PRGs. Therefore, no RAOs or cleanup levels were established for FT-02 groundwater.

5.7.2 Southwest Drainage System (SD-09)

5.7.2.1 Soil

Remedial action is not required for SD-09 soil because the UCL concentration of all chemicals detected in soil were below PRGs. Because the limited residual soil contamination is distributed within the upper few feet of soil at the site, there is no evidence of a threat to groundwater and remedial action is not required to protect groundwater. Therefore, no RAOs or cleanup levels were established for SD-09 soil.

5.7.2.2 Groundwater

Remedial action is not required for SD-09 groundwater because there is no evidence of any current or potential future environmental impact on groundwater based on the low concentration and shallow distribution of contaminants in the overlying soil. Therefore, no RAOs, COCs, or cleanup levels were established for SD-09 groundwater.

5.8 Summary and Conclusions

5.8.1 Current and Future Land Use

The Base closed on September 30, 1993 and is currently under control of the Air Force Base Conversion Agency. The agency is working with the local community to maximize reuse for aviation, education, commercial, and industrial purposes. The Base has been divided into potential reuse parcels identified as airfield, commercial, aviation support, air cargo, general industrial, education/research/training, institutional/medical, and schools. The golf course has been leased; and other areas have been leased to the Williams Gateway Airport Authority and the Arizona State University. Leases are being negotiated for several industrial areas. More definitive reuse information is not available at this time.

5.8.2 Baseline Human Health Assessment

HI values greater than unity were estimated only for the SD-09, and were due almost entirely to incidental ingestion of soil (current and future residential scenarios). The major contributors were antimony, and to a lesser extent, arsenic, cadmium, chromium, and thallium.

However, as noted in Section 5.5.4, the contribution to the total HI due to antimony may be disregarded as a laboratory artifact. Also, the remaining HI, 9.9×10^{-1}, was less than unity. The total HI for individual target organs is also less than 1.0. As discussed in Section 5.5.6, the chromium present was assumed to exist entirely in the hexavalent state, which is unlikely for chromium released into the environment. The RfD for trivalent chromium (1 mg/kg-day) is more than two orders of magnitude higher (less restrictive) than the RfD for hexavalent chromium (5×10^{-3} mg/kg-day), suggesting that the HI for chromium is overly conservative.

None of the sites evaluated resulted in an ILCR for any one pathway greater than the upper limit of the target risk range of 1×10^{-6} to 1×10^{-4}. The following sites resulted in pathway ILCRs within the target risk range:

- Fire Protection Training Area No. 2 (FT-02)
  - Inhalation of volatiles and fugitive dust from soil (future residential and current occupational scenarios)
- Southwest Drainage System (SD-09)
  - Incidental ingestion of soil (current and future residential and current occupational scenarios)

- Inhalation of volatiles and fugitive dust (current and future residential and current occupational scenarios).

When summed across pathways for a given medium (groundwater or soils) or for all media, none of the receptors had a total ILCR greater than 1 x 10^{-4}.

The primary contributors to risk in groundwater and soils include the following COPCs:

- Groundwater
  - Carbon disulfide, methylene chloride, zinc (FT-02)
- Soil
  - Benzene, chloroform, mercury, MEK (FT-02)
  - Arsenic, beryllium, cadmium, chromium, thallium (SD-09).

The potential for future development of production wells in the plume is small even with the Base decommissioned. A future residential scenario has been evaluated to provide an upper-bound estimate of potential risks associated with exposure to this groundwater. These potential risks exist only if a residential well is completed within FT-02 and a resident used the water at the levels assumed in the exposure assessment for 30 years.

5.8.3 Ecological Assessment

There are extensive mechanical stresses at SD-09 related to maintenance mowing that have held the area in a permanent state of arrested secondary succession with little native habitat. Based on the data presented, and taking into consideration the uncertainties inherent in the ecological assessment, the probability for adverse ecological effects occurring at the Base are judged to be insignificant. It can be concluded that alteration of habitat by direct mechanical stresses has had a more profound effect on areas at the Base than the COPC. A comprehensive discussion of the findings of the baseline ecological risk assessment is presented in its final report (IT, 1993d).

5.8.4 Remedial Action Decision Summary

It was determined that further remedial action is required for soil at FT-02 to reduce the concentration of benzene, chloroform, and 1,4-dichlorobenzene in soils to health protective levels, and reduce the total concentration of organic contaminants in soil to prevent any potential future adverse impact to groundwater. It was determined that remedial action is not required for FT-02 groundwater.

It was determined that no remedial action is required for SD-09 soils and groundwater.

6.0 Description of Alternatives

Under CERCLA, a process has been established to develop, screen, and evaluate appropriate remedial alternatives. A wide range of cleanup options were considered for remedial action at FT-02. Remedial alternatives were not developed for SD-09 because this site does not require remedial action.

The initial process options considered during the preliminary screening process are presented in Figure 6-1. The process options were evaluated, and retained or eliminated from further consideration on the basis of technical feasibility. Figure 6-1 presents the rationale for eliminating process options.

A second screening step was then performed to evaluate the remaining process options on the basis of implementability, effectiveness, and cost. The result of this screening process was intended to select one representative process option for each technology type for detailed analysis. The secondary screening was a two-step process. First, the process options retained from preliminary screening were ranked according to the previously defined three criteria to eliminate those options that were obviously inappropriate. The results of this step are presented in Figure 6-2. The process options that remained after this step, shown in Table 6-1, were then subjected to a more detailed evaluation based on the three criteria. After this evaluation was completed, the following three alternatives for FT-02 soils were retained for detailed analysis:

- Alternative FT02-1: No Action
- Alternative FT02-4: Soil Vapor Extraction
- Alternative FT02-5: Bioventing.

These alternatives were developed based on site-specific needs and evaluated using the nine criteria developed by EPA to address CERCLA requirements. The evaluation criteria presented in Figure 6-3 are used to determine the most appropriate alternative. The following sections present detailed descriptions of the two remedial alternatives for contaminated soils at FT-02.

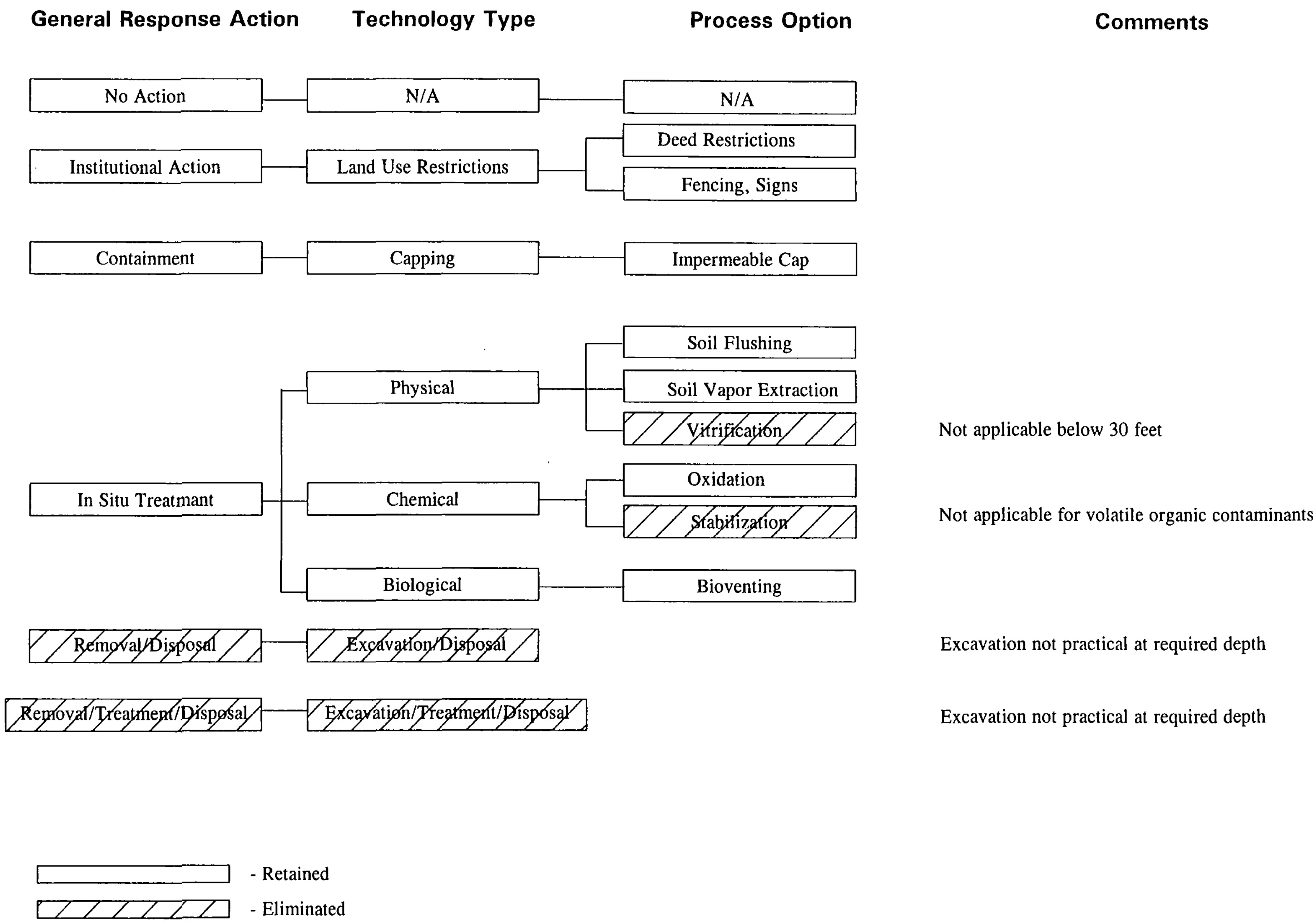

fig2-2a.drw/lld/12-19-94

Figure 6-1. Initial Screening - Soils at FT-02

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Economics
No Action	N/A	N/A	Easily implemented	Not Effective	Low
Institutional Action	Land Use Restrictions	Deed Restrictions	Easily implemented	Somewhat Effective	Low
		Fencing, Signs	Easily implemented	Somewhat Effective	Low
Containment	Capping	Impermeable Layer Cap	Implementable	Somewhat Effective	Moderate
In Situ Treatment	Physical	Soil Flushing	Not easily implemented in soils of varying permeability. Will spread contaminant to deeper uncontaminated soil and groundwater	Potentially effective. May require injection of environmentally significant chemicals to improve the solubility of contaminants.	Expensive. Significant groundwater extraction and treatment system required.
		Soil Vapor Extraction	Implementable. Field pilot test may be required.	Effecive for remediation of fuel hydrocarbons in reasonably permeable soils.	Economical method of remediating vadose zone. Normally requires air pollution controls.
	Chemical	Oxidation	Potentially difficult to implement. Difficult to transport oxidant to deeper contaminated soils. Oxidants will react with soils.	Effectiveness as an in situ process for treating organic compounds in soil has not been demonstrated.	Potentially expensive. Large amounts of oxidizing agents may be required.
	Biological	Bioventing	Implementable. Field pilot tests required.	Effectiveness depends on site-specific characteristics such as microbial population, soil moisture, pH, nutrients, presence of toxicants. Effective for for removal of biodegradable organic compounds.	Economical method of remediating vadose zone. May not require air pollution controls.

- Retained

- Eliminated

Figure 6-2. Secondary Screening - Soils at FT-02

fig2-4ft2.drw/ltd/12-21-94

Table 6-1

FT-02 Soil Alternatives for Inclusion in the Screening Process
Williams Air Force Base

Alternative	Description
FT02-1	No action
FT02-2	Institutional action
FT02-3	Capping
FT02-4	Soil Vapor Extraction
FT02-5	Bioventing

THRESHOLD CRITERIA

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
Requires the assessment of alternatives to determine how they will provide human health and environmental protection from the risks present at a site by eliminating, reducing or controlling the hazardous material detected during the Remedial Investigation.

COMPLIANCE WITH ARARs
Requires the assessment of alternatives to determine how they meet the requirements under federal environmental laws and state environmental or facility siting laws.

PRIMARY BALANCING CRITERIA

LONG-TERM EFFECTIVENESS AND PERMANENCE
This criterion requires the evaluation of residual risks remaining at a site after completion of the remedial action.

REDUCTION OF TOXICITY, MOBILITY, AND VOLUME
This criterion addresses the statutory preference for selecting remedial actions that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances at a site by evaluating the extent to which this is achieved by each alternative.

SHORT-TERM EFFECTIVENESS
This criterion evaluates a remedial alternative's impact on human health and the environment during implementation.

IMPLEMENTABILITY
This criterion evaluates both the technical and administrative feasibility of implementing an alternative including the availability of key services and material required during its implementation.

COST
Under this criterion, capital costs, annual operation and maintenance costs and the net present value of capital O&M costs are assessed for each alternative.

MODIFYING CRITERIA

STATE ACCEPTANCE
This criterion addresses the statutory requirement for substantial and meaningful state involvement. Evaluation of this criterion is conducted by U.S. EPA and addressed during development of the Record of Decision.

COMMUNITY ACCEPTANCE
This criterion assesses the community's apparent preference for, or concerns about, the remedial alternatives. This process is conducted by U.S. EPA and addressed during development of the Record of Decision.

KN/FIG6-3.XLS/5-18-95/F

Figure 6-3. Remedial Alternative Evaluation Criteria

6.1 Alternative FT02-1: No Action

6.1.1 Source Treatment Component

The alternative does not incorporate a treatment component that would result in a permanent reduction of the toxicity or volume of soil contaminants. The no action alternative is included in accordance with the NCP to serve as a baseline for comparison with other alternatives. This alternative would leave approximately 25,000 cubic yards of contaminated soils in place with no additional means to prevent human exposure or migration of contaminants to groundwater. FT-02 soils are contaminated with 2 to 310 mg/kg benzene, 1 to 2 mg/kg chloroform, and 2 to 120 mg/kg 1,4-dichlorobenzene. The alternative does include annual groundwater monitoring for specified COPCs.

6.1.2 Source Containment Component

The alternative does not incorporate a containment component that would restrict the migration of contaminants from soil to groundwater.

6.1.3 Groundwater Component

The remedial alternative does not incorporate a groundwater extraction and treatment component.

The remedial alternative does provide for institution of a 30-year groundwater monitoring program with data collected and analyzed annually to ensure the protection of public health and the environment by confirming that groundwater quality is not being adversely affected by the future migration of soil contaminants. A monitoring program would be established in accordance to with the requirements of 40 Code of Federal Regulations (CFR) 264.91-100 to analyze for specified constituents and/or indicator parameters. Annual groundwater monitoring data would be provided to the regulatory agencies. The details of the groundwater monitoring program would be established during the remedial design/remedial action (RD/RA) phase.

6.1.4 General Components

No institutional controls will be utilized in the implementation of this alternative. Groundwater at the site would be sampled annually and analyzed for specified chemicals and/or indicator parameters.

There are no implementation requirements of concern for this alternative.

The initial risk in implementing the remedial alternative is very low because no remedial action would be taken at the site that could create potential exposures.

The residual risk for this alternative is higher than for the other alternatives because no action would be taken to prevent the migration of contaminants to groundwater. Long-term groundwater monitoring would be required to ensure that contaminants left in place do not impact groundwater.

There are no capital costs associated with this alternative. Annual operation and maintenance (O&M) costs are $0.04 million, which represents the cost of groundwater monitoring and 5-year site reviews. The estimated net present worth of this alternative is $0.9 million. Detailed cost information for Alternative FT02-1 is presented in Appendix B of this document and Appendix E.1 of the OU-3 FS report.

6.1.5 Compliance with ARARs

Because this alternative does not incorporate any active remedial measures, applicable or relevant and appropriate requirements (ARAR) are not applicable.

6.2 Alternative FT02-4: Soil Vapor Extraction

6.2.1 Source Treatment Component

This alternative would volatilize contaminants from the subsurface by imposing a vacuum on the subsurface soils through a series of vadose zone extraction wells. The contaminants in the extracted soil gas would subsequently be destroyed by a fume incineration system. A typical process flow diagram for a soil vapor extraction (SVE) system is presented in Figure 6-4.

The alternative would treat in situ approximately 25,000 cubic yards of soil contaminated with benzene, chloroform, and 1,4-dichlorobenzene at concentrations in excess of cleanup levels. The alternative would reduce the soil concentration of benzene to 1.4 mg/kg, chloroform to 0.53 mg/kg, and 1,4-dichlorobenzene to 7.4 mg/kg. This would result in the removal of approximately 181 kilograms (kg) of benzene, 4 kg of chloroform, and 25 kg of 1,4-dichlorobenzene from FT-02 soils. Other volatile components of JP-4 would also be extracted and destroyed during the operation of the SVE system. The removal of organic contaminants from the soil would prevent the migration of soil contaminants to groundwater.

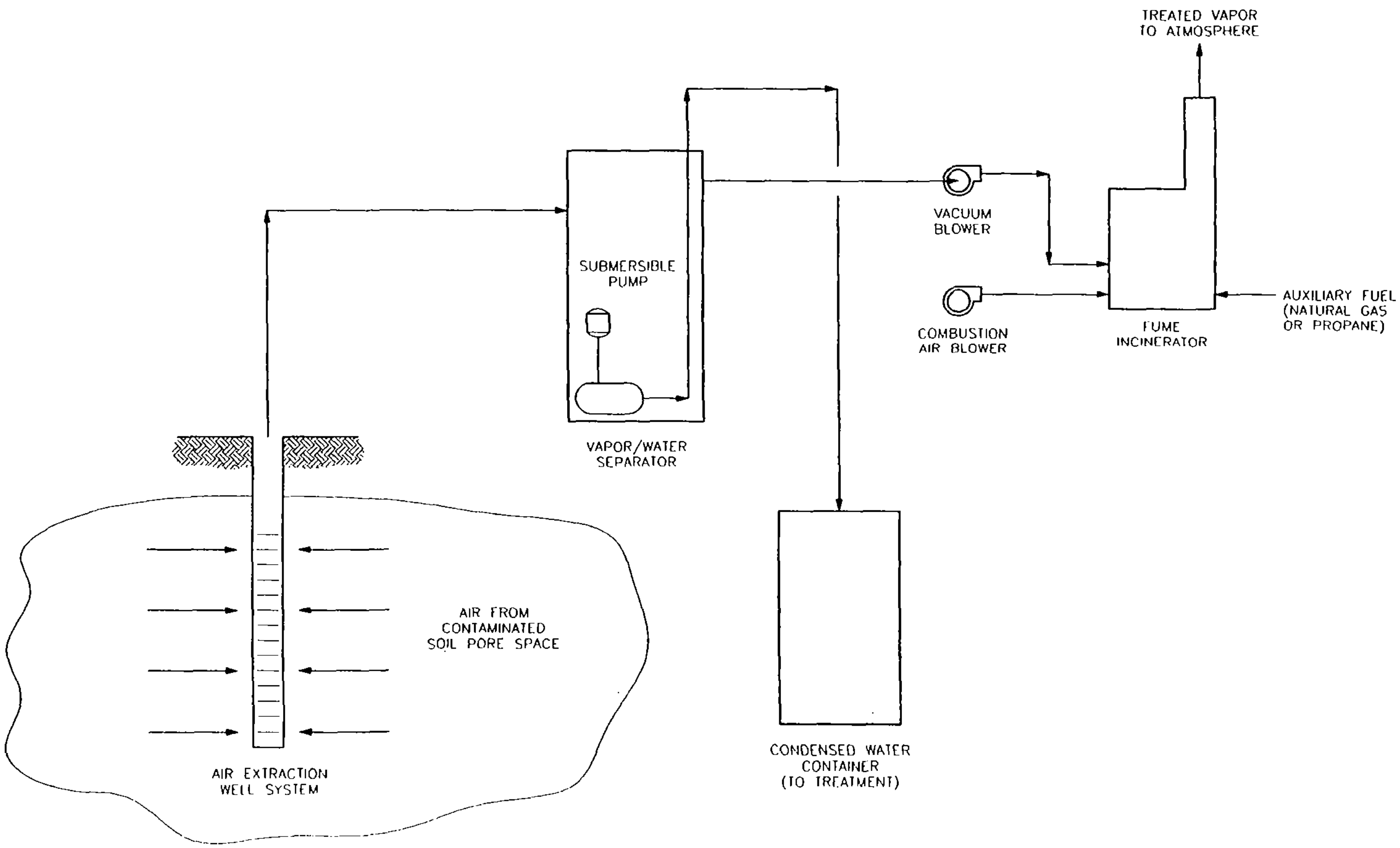

FIGURE 6–4
SOIL VAPOR EXTRACTION (SVE) SYSTEM
CONCEPTUAL FLOW DIAGRAM
FIRE PROTECTION TRAINING AREA
NO. 2 (FT–02) SOILS
OU–3, WILLIAMS AFB

INTERNATIONAL
TECHNOLOGY
CORPORATION

STARTING DATE: 5/23/95	DATE LAST REV.:	DRAFT CHCK. BY:	INITIATOR: W. ANDERSON	DWG. NO.: 409877-B-18
DRAWN BY: P JONES	DRAWN BY:	ENGR. CHCK BY: K. TRUONG	PROJ. MGR.: W. CARTER	PROJ. NO.: 409877

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Based on data currently available, the SVE system is expected to require the installation of nine soil gas extraction wells at depths varying from 10 to 86 feet deep. One well at the large burn pit would be connected to a vacuum blower rated for 40 standard cubic feet per minute (scfm) at 10 inches of mercury vacuum. The remaining extraction wells to be located at the small burn pit would be manifolded to a vacuum blower rated for approximately 500 scfm at 18 inches of mercury. The fume incinerator would be designed to treat the combined emissions from both SVE blowers. The fume incinerator is estimated to be rated for 3 million British Thermal Units (Btu) per hour. The size and configuration of the SVE system components would be finalized during remedial design after an SVE pilot test is completed at the site.

6.2.2 Source Containment Component

The alternative does not incorporate a containment component that would restrict the migration of contaminants from soil to groundwater. A containment component is not required because the treatment component would effectively remediate the contaminated soils.

6.2.3 Groundwater Component

The remedial alternative does not incorporate a groundwater extraction and treatment component because groundwater is not currently contaminated. Groundwater monitoring would not be required after the concentration of COCs in soil are reduced to cleanup levels.

6.2.4 General Components

The initial cancer and noncancer risks for contaminated soils at FT-02 are within acceptable levels. The total ILCR for future residents of the site from exposure to all chemicals in FT-02 soil summed across all exposure pathways is 3.4×10^{-5}. The total noncancer HI is 0.94. However, the concentration and distribution of contaminants in the soil presents a future threat to groundwater quality. The reductions in soil concentrations achieved through SVE treatment would prevent the future migration of contaminants to groundwater.

There are no major implementation concerns associated with the construction and operation of an SVE system. The units operate with limited operator attention. Periodic monitoring of the fume incinerator emissions may be required to confirm compliance with Maricopa County air quality standards.

No institutional controls would be required as a component of this alternative.

The alternative is expected to require 2 years to achieve cleanup levels in soil.

The initial capital cost of this alternative is estimated to be $0.8 million. Annual O&M costs are estimated to be approximately $0.3 million. The net present worth cost of this alternative is estimated to be $1.2 million. Detailed cost information for Alternative FT02-4 is presented in Appendix B of this document and Appendix E.1 of the OU-3 FS report.

6.2.5 Compliance with ARARs

No chemical-specific ARARs exist for COCs in soils. This alternative would meet all applicable location- and action-specific ARARs listed in Appendix C.

The location-specific ARAR concerning the protection of significant archaeological artifacts is a relevant and appropriate requirements. Prior to the initiation of any remedial activities at the site, remedial plans will be reviewed with the State Historic Protection Officer (SHPO) to obtain his approval. If any obvious archaeological artifacts are encountered during remedial operations, work will be stopped and the SHPO will be consulted. Through these actions, Alternative FT02-4 would comply with the archaeological ARAR.

The action-specific ARAR concerning surface water control is considered relevant and appropriate. The alternative will meet this requirement by providing storm water collection in areas where soil cuttings are stored.

The action-specific ARAR concerning on-site container storage is an applicable requirement. The alternative will comply with the requirements of RCRA Section 40 CFR 264 concerning the handing, inspection, and maintenance issues associated with the storage of soil cuttings and water extracted from the subsurface by the SVE system.

The action-specific ARAR concerning air emissions during remediation is an applicable requirement. This requirement will be met through the installation and use of a fume incineration system to reduce the concentration of organic vapors in soil gas extracted by the SVE system. The fume incinerator would be designed, operated, and maintained to ensure compliance with this ARAR.

The action-specific ARAR concerning the treatment of extracted soil moisture will be met by containerizing the water in a 55-gallon drum or a tote tank for subsequent transport to and treatment by the ST-12 groundwater treatment system. Currently, the treated groundwater at

ST-12 is discharged to the sanitary sewer and must comply with pretreatment limits in the Base's permit with the local publicly owned treatment works. In the future, the treated water may be reinjected at ST-12. At that time, the treated water would have to comply with reinjection standards.

6.3 Alternative FT02-5: Bioventing

6.3.1 Source Treatment Component

This alternative delivers oxygen to contaminated soils by forced air injection to stimulate aerobic metabolism of organic contaminants by indigenous soil microorganisms. A blower would inject air into the soil through a series of air injection wells screened in the contaminated soil. The air would be supplied to the soil at rates that would provide sufficient oxygen to stimulate biodegradation while minimizing volatilization and release of contaminants to the atmosphere. A typical process flow diagram for a bioventing system is presented in Figure 6-5.

The alternative would treat in situ approximately 25,000 cubic yards of soil contaminated with benzene, chloroform, and 1,4-dichlorobenzene at concentrations in excess of cleanup levels. The alternative would reduce the soil concentration of benzene to 1.4 mg/kg, chloroform to 0.53 mg/kg, and 1,4-dichlorobenzene to 7.4 mg/kg. This would result in the removal of approximately 181 kg of benzene, 4 kg of chloroform, and 25 kg of 1,4-dichlorobenzene from FT-02 soils. Other biodegradable components of JP-4 would also be converted to innocuous chemicals such as carbon dioxide and water. The removal of organic contaminants from the soil would prevent the migration of soil contaminants to groundwater.

Based on data currently available, the bioventing system is expected to require the installation of nine air injection wells at depths varying from 10 to 86 feet deep. All nine wells would be connected to a 200 scfm blower rated for 10 pounds per square inch gage (psig) pressure. Due to the proposed configuration of the bioventing system, it is estimated that air pollution controls would not be required because the potential for volatile emissions is very low. The bioventing system will use a low rate of air injection (less than 1 scfm per foot of vent well screen). Because horizontal permeability is generally greater than vertical permeability, the injected air will tend to move outward rather than upward. This will promote in-situ biodegradation of organic vapors as they move slowly outward from the injection point.

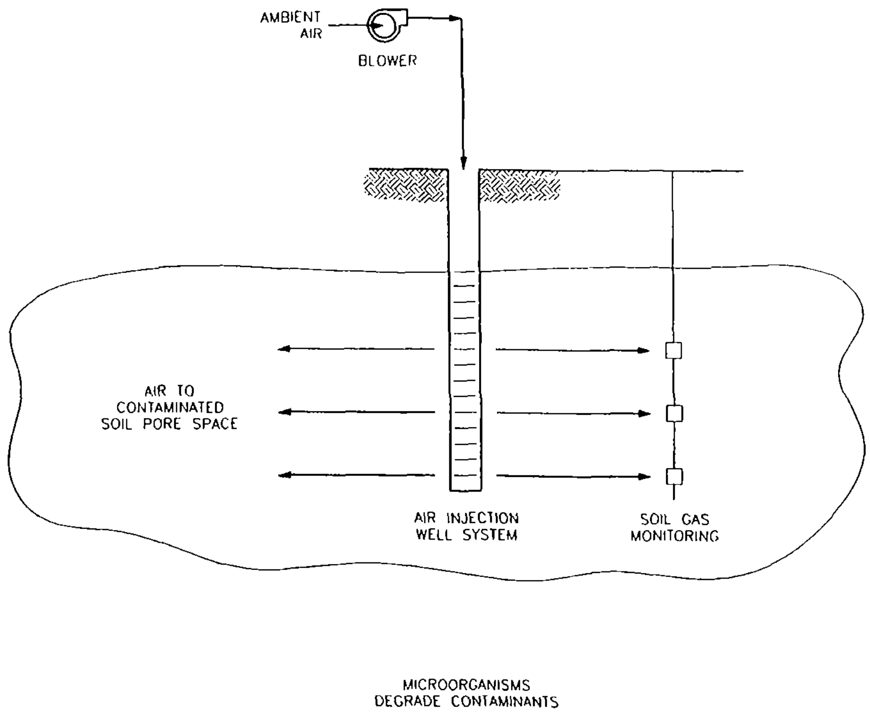

FIGURE 6-5
BIOVENTING SYSTEM
CONCEPTUAL FLOW DIAGRAM
FIRE PROTECTION TRAINING AREA
NO. 2 (FT-02) SOILS
OU-3, WILLIAMS AFB

INTERNATIONAL TECHNOLOGY CORPORATION

STARTING DATE: 5/23/95 | DATE LAST REV.: | DRAFT CHCK. BY: | INITIATOR: W. ANDERSON | DWG. NO. 409877-B-19
DRAWN BY: P.JONES | DRAWN BY: | ENGR. CHCK. BY: K. TRUONG | PROJ. MGR.: W. CARTER | PROJ. NO.: 409877

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The size and configuration of the bioventing system components would be finalized during remedial design after a bioventing pilot test is completed at the site.

6.3.2 Source Containment Component

The alternative does not incorporate a containment component that would restrict the migration of contaminants from soil to groundwater. A containment component is not required because the treatment component would effectively remediate the contaminated soils.

6.3.3 Groundwater Component

The remedial alternative does not incorporate a groundwater extraction and treatment component because groundwater is not currently contaminated. Groundwater monitoring would not be required after the concentration of COCs in soil are reduced to cleanup levels.

6.3.4 General Components

The initial cancer and noncancer risks for contaminated soils at FT-02 are within acceptable levels. The total ILCR for future residents of the site from exposure to all chemicals in FT-02 soil summed across all exposure pathways is 3.4×10^{-5}. The total noncancer HI is 0.94. However, the concentration and distribution of contaminants in the soil presents a future threat to groundwater quality. The reductions in soil concentrations achieved through bioventing treatment would prevent the future migration of contaminants to groundwater.

There are no major implementation concerns associated with the construction and operation of a bioventing system. The units operate with limited operator attention. Initial monitoring of ambient air in the vicinity of the treated soils will be required to confirm compliance with Maricopa County air quality standards.

No institutional controls would be required as a component of this alternative.

The alternative is expected to require 4 years to achieve cleanup levels in soil.

The initial capital cost of this alternative is estimated to be \$0.6 million. Annual O&M costs are estimated to be approximately \$0.1 million. The net present worth cost of this alternative is estimated to be \$1.1 million. Detailed cost information for Alternative FT02-5 is presented in Appendix B of this document and Appendix E.1 of the OU-3 FS report.

6.3.5 Compliance with ARARs

No chemical-specific ARARs exist for COCs in soils. This alternative would meet all applicable location- and action-specific ARARs listed in Appendix C. The location-specific ARAR concerning the protection of significant archaeological artifacts is a relevant and appropriate requirement. Prior to the initiation of any remedial activities at the site, remedial plans will be reviewed with the SHPO to obtain his approval. If any obvious archaeological artifacts are encountered during remedial operations, work will be stopped and the SHPO will be consulted. Through these actions, Alternative FT02-4 would comply with the archaeological ARAR.

The action-specific ARAR concerning surface water control is considered relevant and appropriate. The alternative will meet this requirement by providing storm water collection in areas where soil cuttings are stored.

The action-specific ARAR concerning on-site container storage is an applicable requirement. The alternative will comply with the requirements of RCRA Section 40 CFR 264 concerning the handing, inspection, and maintenance issues associated with the storage of soil cuttings.

The action-specific ARAR concerning air emissions during remediation is an applicable requirement. It is anticipated that emission controls will not be required to comply with this ARAR because emissions from the bioventing system should be below limits specified by the Maricopa County Air Pollution Control Division. To ensure compliance, a surface emission monitoring program will be initiated following start-up. Surface emissions will be monitored using flux chambers. Air samples collected will be analyzed for BTEX and total volatile hydrocarbons (TVH) by EPA method TO-3. If total hydrocarbon emissions approach the 3-pound per day limit, the air injection rate will be reduced.

The action-specific requirement concerning treatment of extracted soil moisture is not an ARAR for the bioventing alternative because soil gas will not be mechanically extracted.

7.0 Comparative Analysis of Alternatives

The final phase in the evaluation of remedial alternatives involves a comparison of the various alternatives. The advantages and disadvantages of each alternative are reviewed relative to each of the nine EPA evaluation criteria presented in Figure 6-3. The following sections present the evaluation process for FT-02. Site SD-09 does not require remedial action and, therefore, is not discussed in this section. For each evaluation criterion discussed, the apparent best alternative is identified first. Table 7-1 summarizes the results of the remedial alternative evaluation process for FT-02.

7.1 Overall Protection of Human Health and the Environment

Both Alternatives FT02-4 and FT02-5 should reduce the soil concentrations of benzene, chloroform, and 1,4-dichlorobenzene to cleanup levels. Treatability studies/pilot tests are recommended to confirm the effectiveness of both technologies. SVE and bioventing would both have the additional treatment benefit of reducing the concentrations of other organic contaminants, thereby preventing the migration of contaminants to groundwater. The no-action Alternative FT02-1 would not provide long-term protection of human health and the environment because it would not reduce the concentration of contaminants in the soil.

7.2 Compliance with ARARs

Alternatives FT02-4 and FT02-5 should meet all applicable location-specific and action-specific ARARs as presented in Appendix C. No chemical-specific ARARs exist for soils. EPA does not consider Alternative FT02-1 to be a "remedial action" because no action is being taken. Therefore, the requirements of CERCLA Section 121 concerning ARARs do not apply to Alternative FT02-1, and ARARs are not identified.

7.3 Long-Term Effectiveness and Permanence

Because Alternatives FT02-4 and FT02-5 would both reduce the concentrations of COCs in soil to cleanup levels, they would provide permanent and equivalent reductions in the residual risks associated with the site, such as exposure to contaminated soil and migration of contaminants to groundwater. The attainment of cleanup levels under either alternative would reduce any residual risk to acceptable levels.

Table 7-1

Comparison of Cleanup Alternatives
Fire Protection Training Area No.2 (FT-02), OU-3
Williams Air Force Base

EPA Evaluation Criteria	FT02-1 No Action	FT02-4 Soil Vapor Extraction	FT02-5 Bioventing
Overall Protection of Human Health and the Environment	Not Protective	Protective	Protective
Compliance with ARARs	Not applicable	Complies	Complies
Long-Term Effectiveness and Permanence	Not a permanent solution	Achieves a permanent and effective solution	Achieves a permanent and effective solution
Reduces Toxicity, Mobility or Volume	No reduction	Reduces toxicity and mobility of contaminants	Reduces toxicity and mobility of contaminants
Short-Term Effectiveness	Not effective	Effective	Effective
Implementability	Most implementable	Easily implementable	Easily implementable
Cost (Present worth)	$0.9 million	$1.2 million	$1.1 million
State Acceptance	--	--	Acceptable[a]
Community Acceptance	--	--	Acceptable[a]
Estimated Remedial Duration (years)	>30	2	4

[a]No comments were received from the State of Arizona or the community concerning the implementation of the bioventing remedy at the public meeting or during the public comment period.

Alternative FT02-1 would not provide any long-term effectiveness or permanence because there would be no reduction in risk associated with human exposures or migration of contaminants to groundwater.

7.4 Reduction in Toxicity, Mobility, and Volume Through Treatment

Alternative FT02-4 could provide greater reduction of chloroform concentrations than Alternative FT02-5 because this compound is somewhat biologically resistant, but readily volatilized. Although volatilization is not the primary pathway of contaminant removal for bioventing, reductions in chloroform concentrations would occur via this route. Treatability testing prior to the implementation of Alternative FT02-5 would verify the effectiveness of bioventing in reducing chloroform and 1,4-dichlorobenzene concentrations. Both alternatives should provide approximately equivalent reductions in benzene and 1,4-dichlorobenzene concentrations. Although 1,4-dichlorobenzene is somewhat resistant to biological degradation and, therefore, less amenable than nonchlorinated organics to treatment via bioventing, it is also a semivolatile compound that is not as readily volatilized as VOCs such as benzene and chloroform. Both alternatives provide a reduction in the concentration of other soil contaminants not requiring remedial action to meet cleanup levels, thereby preventing the migration of contaminants to groundwater. Both Alternatives FT02-4 and FT02-5 are essentially equally effective in reducing the mobility of soil contaminants. Alternative FT02-1 would provide no reduction in the mobility of contaminants or the volume of contaminated soil, although some reduction in toxicity could occur over time due to natural attenuation processes.

7.5 Short-Term Effectiveness

Alternative FT02-1 would pose no additional short-term risks to the general public, workers, or the environment. Alternative FT02-5 would pose slightly fewer short-term risks than Alternative FT02-4 because bioventing systems are designed to minimize the volatilization of contaminants and, therefore, do not typically require emission controls. SVE promotes the volatilization of contaminants, which would be drawn aboveground to be treated via fume incineration or carbon adsorption prior to discharge to the atmosphere. The enhanced short-term risk associated with SVE arises from the potential malfunction or failure of the air pollution control equipment, which could result in increased exposure to VOC contaminants by site workers and temporary noncompliance with air quality standards.

7.6 Implementability

Alternative FT02-1 has no attendant implementability concerns. Alternatives FT02-4 and FT02-5 are both readily implementable, with FT02-5 projected to require an additional 2 years to complete over FT02-4. While O&M requirements are not significant for either alternative, air pollution control equipment is not required for Alternative FT02-5; therefore, O&M requirements for this alternative are correspondingly lower.

7.7 Cost

Table 7-2 summarizes the estimated capital costs, O&M costs, and present worth costs for the three alternatives. At $0.9 million, the no-action Alternative FT02-1 has the lowest net present worth. Between the two alternatives involving treatment, alternative FT02-5 has a net present worth of $1.1 million, while Alternative FT02-4 has a net present worth of $1.2 million. Alternative FT02-5 is less expensive than Alternative FT02-4 because bioventing does not require the installation of air pollution control equipment.

Table 7-2

Summary of Remedial Alternative Cost Estimates
Fire Protection Training Area No. 2 (FT-02), OU-3
Williams Air Force Base

Cost Component[a]	FT02-1 No Action ($)	FT02-4 Soil Vapor Extraction ($)	FT02-5 Bioventing ($)
Capital Cost	0	0.8	0.6
Annual Operating and Maintenance Cost (O&M)	0.04	0.3	0.1
Present Worth Cost	0.9	1.2	1.1

[a] All cost figures are reported in millions. A 5 percent discount rate and 30 years was used to calculate present worth costs.

8.0 Selected Remedy

The selected remedy for FT-02 is Alternative FT02-5: Bioventing. The specific components of this alternative are presented in Section 6.2 and described in this section.

Alternative FT02-5 satisfies the two threshold criteria, overall protection of human health and the environment and compliance with ARARs, and provides the best balance of the nine evaluation criteria presented in Figure 6-3. The selected remedy will provide the greatest level of effectiveness that is technically and economically feasible. The criterion of protection of human health and the environment is appropriately balanced with both effectiveness and technical/economic feasibility.

8.1 Major Components of the Selected Remedy

This alternative delivers oxygen to contaminated soils by forced air injection to stimulate aerobic metabolism of organic contaminants by indigenous soil microorganisms. A blower will inject air into the soil through a series of air injection wells screened in the contaminated soil. The air will be supplied to the soil at rates that will provide sufficient oxygen to stimulate biodegradation while minimizing volatilization and release of contaminants to the atmosphere. Therefore, emission controls are typically not required with bioventing systems. A typical process flow diagram for a bioventing system is presented in Figure 6-5.

The alternative would treat in situ approximately 25,000 cubic yards of soil contaminated with benzene, chloroform, and 1,4-dichlorobenzene at concentrations in excess of cleanup levels. The alternative would reduce the soil concentration of benzene to 1.4 mg/kg, chloroform to 0.53 mg/kg, and 1,4-dichlorobenzene to 7.4 mg/kg. These cleanup levels are based on EPA Region IX PRGs, which are risk based. These contaminant reductions would result in the removal of approximately 181 kg of benzene, 4 kg of chloroform, and 25 kg of 1,4-dichlorobenzene from FT-02 soils. The residual human health risks remaining after remedial action is complete at FT-02 will be within the 10^{-6} to 10^{-4} acceptable risk range. Other biodegradable components of JP-4 would also be converted to innocuous chemicals such as carbon dioxide and water. The general reduction in the concentration of organic compounds in the soil will also prevent the migration of soil contaminants to groundwater.

Based on data currently available, the bioventing system is expected to require the installation of nine air injection wells at depths varying from 10 to 86 feet deep. All nine wells will be connected to a 200 scfm blower rated for 10 psig pressure. Due to the proposed configuration of the bioventing system, it is estimated that air pollution controls would not be required because the potential for volatile emissions is very low. The bioventing system will use a low rate of air injection (less than 1 scfm per foot of vent well screen). Because horizontal permeability is generally greater than vertical permeability, the injected air will tend to move outward rather than upward. This will promote in-situ biodegradation of organic vapors as they move slowly outward from the injection point. The size and configuration of the bioventing system components will be finalized during remedial design after a bioventing pilot test is completed at the site.

Soil and soil gas monitoring will be conducted periodically during the operation of the bioventing system to evaluate the effectiveness of the remedial action and determine when RAO-based cleanup levels have been met for COCs. Respiration tests will be conducted every 6 months to measure bioactivity as determined by the rate of oxygen consumption. Soil gas samples will be collected annually and analyzed for BTEX and TVH by EPA method TO-3. Soil samples will be collected annually adjacent to vent wells and at selected monitoring points and analyzed for total recoverable petroleum hydrocarbons, VOCs, and moisture content. The analysis for VOCs will include benzene, chloroform, and 1,4-dichlorobenzene. Monitoring points in the vadose zone shall be determined during the RD/RA process.

Because bioventing will reduce the concentration of soil contaminants such that the use of and exposure to the site is not restricted, a 5-year review will not be required unless the remedial action is not fully complete within 5 years of its initiation.

8.2 Implementation Concerns

There are no major implementation concerns associated with the construction and operation of a bioventing system. The units operate with limited operator attention. Initial monitoring of ambient air in the vicinity of the treated soils will be required to confirm compliance with Maricopa County air quality standards. Periodic soil gas monitoring and in situ respiration tests will be required to monitor the progress of remediation. Soil samples will be collected and analyzed at the end of the remedial action to confirm that RAO-based cleanup levels have been met for COCs. A bioventing pilot test will be conducted prior to remedial design. Some changes may be made to the remedy as a result of additional information gathered before, during, or after remedial design. However, these changes in general reflect modifications to the remedy resulting from the engineering design process.

The alternative is expected to require 4 years to achieve cleanup levels in soil.

8.3 Cost

The initial capital cost of this alternative is estimated to be $0.6 million. This cost includes all equipment and installation costs associated with engineering, the bioventing pilot test, and the installation of the air injection well network, associated piping, piezometers, and the bioventing blower skid. Annual O&M costs are estimated to be approximately $0.1 million. These costs represent primarily the operating labor, maintenance, utilities, and analytical work necessary for the efficient operation of the bioventing treatment system. The net present worth cost of this alternative is estimated to be $1.1 million. This relates to a total unit cost of approximately $44 per cubic yard for the 25,000 cubic yards of contaminated soil treated in situ.

9.0 Statutory Determinations

Under Section 121 of CERCLA, the selected remedy must be protective of human health and the environment and must comply with all ARARs. The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. Remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as a major part of the remedy are preferable. How the selected remedy meets these requirements is discussed in this chapter.

The State of Arizona and the communities surrounding Williams AFB were involved in the determination of the selected remedy. The state was represented in the process by ADEQ and ADWR, both of whom are parties to the FFA. They have been intrinsically involved in the review and approval of all documents and decisions concerning the various stages of the remedial process, including all work plans, RI/FS reports, proposed plans, and RODs.

The communities surrounding Williams AFB have been involved in the decision-making process through the TRC, the RAB, and through public meetings and comment periods on proposed remedies and removal actions. Chapter 11.0 of this document addresses the communities' involvement in more depth.

Alternative FT02-5, bioventing, was chosen as the selected remedy. The selected remedy represents the best balance among alternatives with respect to the pertinent criteria, given the scope of this action.

9.1 Protection of Human Health and the Environment

The selected remedy protects human health by reducing the concentration of the three COCs in FT-02 soils (benzene, chloroform, and 1,4-dichlorobenzene) via bioventing to cleanup levels. The RAO for FT-02 sets the following cleanup levels for COCs in soils: 1.4 mg/kg for benzene, 0.53 mg/kg for chloroform, and 7.4 mg/kg for 1,4-dichlorobenzene. These cleanup levels ensure that the individual constituent ILCR for each chemical of concern will be reduced to 10^{-6}. The total residual ILCR remaining after the remedial action is complete, determined for all chemicals summed across all exposure pathways, will be within EPA's acceptable risk range of 10^{-6} to 10^{-4}. The total residual noncancer HI for the site will be less than 1.0. Bioventing the contaminated soils will also reduce the concentration of other biodegradable constituents of JP-4, thereby preventing the future migration of organic soil contaminants to groundwater. There are no short-term threats associated with the selected remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the remedy.

9.2 Attainment of ARARs

The selected remedy will comply with all ARARs. These ARARs are presented in Appendix C. A detailed discussion of how the remedy will comply with ARARs is presented in Section 6.3.5.

9.3 Cost Effectiveness

The selected remedy (bioventing) was evaluated for cost effectiveness against Alternative FT02-1 (no action) and Alternative FT02-4 (SVE). Although the selected remedy is more expensive than the no-action alternative, the no-action alternative is not protective of human health and the environment, principally because of the potential future risk of contaminant migration to groundwater. Bioventing was also determined to be more cost effective than SVE because of its lower estimated present value cost.

9.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Possible

The selected remedy (bioventing) utilizes permanent solutions and treatment technologies to the maximum extent practicable. It is the remedial alternative that represents the optimum balance among the alternatives with respect to the nine EPA evaluation criteria, especially the balancing criteria of short-term effectiveness, implementability, and cost. Both bioventing and SVE are approximately equivalent in terms of their long-term effectiveness and permanence, and the degree to which they achieve reductions in the toxicity, mobility, or volume of contamination through treatment. However, unlike an SVE system, a bioventing treatment system will not extract contaminants from the subsurface for ultimate destruction in an aboveground treatment unit, such as a fume incinerator. Therefore, site workers and the public have a lower risk of exposure to uncontrolled emissions, in comparison to an SVE system. Because air pollution controls are not required, a bioventing system is more easily implemented than an SVE system. It requires less installation and start-up effort, as well as less maintenance and emissions testing. The preferred remedy also has a lower present worth cost than the SVE alternative. Although bioventing is estimated to require 2 years more than SVE to remediate the site, the additional cost required for the SVE alternative is not warranted because the current human health risks at the site are within acceptable levels, and it is improbable that soil contaminants will impact groundwater over this additional 2-year period.

The ADEQ and ADWR were involved at each step in the remedy selection process for OU-3, reviewing and approving the EE/CA, RI/FS, proposed plan, proposed plan fact sheet, and the ROD.

The public was invited to offer comment at each step in the process through public comment periods advertised in local newspapers and at a public meeting. A fact sheet providing a condensed version of the remedy selection process contained in the proposed plan was distributed to the media along with a news release and to those who attended the public meeting. In addition, the proposed plan and the proposed plan fact sheet were placed in the information repository located at the Gilbert Public Library. The RAB was briefed on the selected remedy for OU-3.

9.5 Preference for Treatment as a Principal Element

By treating the contaminated soils in situ via bioventing, the selected remedy addresses the principal threats posed by the site through the use of a treatment technology. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied.

10.0 Documentation of Significant Changes

The proposed plan for OU-3 was released for public comment on June 26, 1995 and a public meeting was held on July 18, 1995. The OU-3 proposed plan identified bioventing as the preferred alternative for FT-02, and no further action as the preferred alternative for SD-09. No written or verbal comments were received during the public comment period, and the USAF, EPA, and the State of Arizona determined that no significant changes were necessary to the preferred alternatives for the two sites, as originally identified in the proposed plan.

11.0 Responsiveness Summary

11.1 Overview

The USAF published the proposed plan for cleanup of the groundwater and soil at Operable Unit 3 (OU-3), Williams AFB in June 1995; the public comment period began June 26, 1995 and extended through July 25, 1995. A public meeting was held at the Centennial Conference Center in Mesa, Arizona to present the plan to the public on July 18, 1995. The preferred alternative specified in the ROD involves in situ treatment of the contaminated soil via bioventing. The bioventing system will inject air into the subsurface soil to stimulate the biodegradation of organic contaminants by indigenous soil microorganisms. The bioventing system will be designed to comply with the applicable Maricopa County air quality requirement concerning volatile organic compounds emissions during remediation. The bioventing system will operate until the concentrations of benzene, chloroform, and 1,4-dichlorobenzene in the soils are reduced to cleanup levels.

The public meeting held on July 18, 1995 was poorly attended and no comments or questions were received.

11.2 Background on Community Involvement

To date, the level of community interest and concern regarding the groundwater and soil contamination at OU-3 in particular and environmental cleanup in general at Williams AFB can be characterized as extremely low. In contrast, base re-use issues have sparked great interest, which in turn have created an indirect interest on what effect, if any, the environmental contamination at the base will have on future use or transfer of base property.

The RAB has been briefed on the progress of environmental investigation at OU-3 and the selected remedy identified in the ROD. An ad was placed in the *Tribune* announcing to the public that the proposed plan had been placed in the information repository at the Gilbert Public Library and that there was an opportunity to offer input during the 30-day comment period. A fact sheet describing the selected remedy for cleanup of OU-3 was also placed in the information repository and distributed at the public meeting. The ad announcing the public comment period and the availability of the proposed plan for review contained the time, location, and subject matter of the public meeting. A news release was distributed to the media listed in the community relations plan.

11.3 Summary of Comments Received During the Public Comment Period and Air Force Responses

The public comment period on the proposed plan for cleanup of the groundwater and soils at OU-3 was held from June 25 through July 26, 1995. No written comments were received.

11.4 Community Relations Activities at Williams Air Force Base

Community relations activities at Williams AFB have been guided by a written community relations plan. Design of the site-specific community relations plan was guided by the level and types of concern expressed by local community members in one-on-one interviews conducted in November 1989.

An information repository containing correspondence, fact sheets, and other pertinent documents, such as the community relations plan, has been established and is currently maintained at the Gilbert Public Library, 665 North Gilbert Road, No. 152, Gilbert, Arizona 85234, (602) 892-3141.

A TRC provided review and comment on actions and proposed actions with respect to releases and threatened releases of hazardous substances at Williams AFB until it was replaced by the RAB in February, 1994. The purpose of the RAB (and the TRC before it) is to serve as an advisory committee to the USAF on the IRP at Williams AFB. The RAB, whose expanded membership includes representatives of the USAF, State and federal regulatory agencies, and community stakeholders, meets quarterly to discuss the results of the field investigations and to discuss proposals for interim or final cleanup actions. In addition to IRP issues, the RAB covers Base reuse topics.

Nine fact sheets have been written and distributed that describe planned, ongoing, and completed activities under the IRP at Williams AFB. Six were information updates on progress of environmental investigation. Three others described the proposed plans for cleanup of OU-1, OU-2, and OU-3.

A 35-millimeter slide presentation describing the IRP has been developed for the Base Commander's use with community and civic groups. Before the training wing was de-activated, the Commander or his designee briefed numerous groups about environmental activities at Williams AFB.

News releases and public notices have been submitted to the local papers announcing milestones in the IRP. Topics include:

- Signing of the FFA
- Availability for comment on engineering evaluation/cost analyses for the Radioactive Instrumentation Burial Area, the Fire Protection Training Area 1, and the Pesticide Burial Area
- Availability of the OU-1, -2 and -3 RI reports for review
- Availability of the OU-1, -2, and -3 proposed plans for public comment
- Announcement of public meeting to present the Proposed Plan for OU-1, -2, and -3.

Fact sheets describing the proposed plans to clean up OU-1 and OU-2 were mailed to the mailing list contained in the community relations plan, along with the announcement of the public comment period and the public meeting. The broadcast media also received a public service announcement giving the time and location of the public meeting. Notices in the *Arizona Republic/Phoenix Gazette* announced the public comment periods for OU-1 and -2. The *Tribune* carried notices for the public comment period for the OU-3 proposed plan.

Four public meetings have been held at the Mesa Conference Center Complex as part of the community relations program at Williams AFB. Fifty to 75 citizens attended the first meeting held on June 16, 1992 to present the proposed plan for cleanup of OU-2, and less than 20 citizens attended the second and third public meetings held October 14, 1993 and February 10, 1994 to present the proposed plan for cleanup of OU-1. Less than a half dozen bona fide community members attended the public meeting held on July 18, 1995 to present the proposed plan for OU-3. At each public meeting, attendees were given an agenda, a fact sheet, and graphic representations of cleanup alternatives as handouts. Copies of the FSs and proposed plans were available at each of the four meetings for review. Press packets, including the handouts, hard copies of slides, and the news releases, were available for media representatives who attended the meeting.

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APPENDIX A

DETERMINATION OF CHEMICALS OF CONCERN, CLEANUP LEVELS, AND REMEDIAL ACTION OBJECTIVES FOR OU-3 SOIL AND GROUNDWATER

Table A-1

Determination of Chemicals of Concern (COC) and Cleanup Levels in Soil
Fire Protection Training Area No. 2 (FT-02), OU-3
Williams Air Force Base

Chemicals of Potential Concern	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentrations (mg/kg)	PRG (mg/kg)	UCL Concentration[a] (mg/kg)	COC	Decision Basis
Organics						
1,2-Dichlorobenzene	0.36 to 1	3 to 23	2,300	4	No	UCL below PRG
1,4-Dichlorobenzene[b]	0.36 to 1	2 to 120	7.4[c]	8.2	Yes	Requires action to meet PRG
Acetone	0.011 to 0.012	0.012 to 0.029	2,000	0.017	No	UCL below PRG
Benzene[b]	0.005 to 2	2 to 310	1.4[c]	7.3	Yes	Requires action to meet PRG
Bis(2-ethylhexyl)phthalate	0.36 to 0.39	0.078 to 2.3	32	1.4	No	UCL below PRG
Chloroform[b]	0.005 to 1	1 to 2	0.53[c]	0.66	Yes	Requires action to meet PRG
Ethyl benzene	0.005 to 1	1 to 170	2,900	6.6	No	UCL below PRG
Methyl ethyl ketone	0.011 to 10	13 to 1400	8,700	112	No	UCL below PRG
Methylene chloride	0.005 to 1	0.075 to 11	11	3	No	UCL below PRG
Toluene	0.005 to 2	3 to 260	1,900	9.4	No	UCL below PRG
Xylenes	0.005 to 2	2 to 640	980	27	No	UCL below PRG
Inorganic						
Cadmium	2	1 to 5	38	4.6	No	UCL below PRG
Chromium	3	4 to 24	210	16	No	UCL below PRG
Copper	6 to 7	13 to 44	2,800	20	No	UCL below PRG
Lead	0.7 to 10	4.0 to 70	400	18	No	UCL below PRG
Mercury	0.3	5.9	23	7	No	UCL below PRG
Nickel	9 to 10	13 to 28	1,500	18	No	UCL below PRG
Zinc	5	33 to 100	23,000	62	No	UCL below PRG

[a]UCL Concentration is calculated for data collected from surface to 25 feet bgs.
[b]Chemical of concern for FT-02 soil.
[c]Cleanup level.

Table A-2

Determination of Chemicals of Concern (COC) and Cleanup Levels in Groundwater
Fire Protection Training Area No. 2 (FT-02), OU-3
Williams Air Force Base

Chemicals of Potential Concern	Value or Range of Detection Limits (µg/L)	Range of Detected Concentrations (µg/L)	Base-Specific[a] Background Range or Value (µg/L)	PRG (µg/L)	UCL (µg/L)	Decision Basis	COC
Organics							
Acetone	10	2.0 to 4.0	NA[b]	610	4.3	UCL concentration below PRG	No
Carbon Disulfide	5	1.0 to 6.0	NA	21	6.4	UCL concentration below PRG	No
Methylene Chloride	0.5 to 15	0.7 to 6.0	NA	5	2.9	UCL concentration below PRG	No
Inorganics							
Lead	1 to 5	6.0 to 21.0	ND[c]	15	6.5	UCL concentration below PRG	No
Zinc	20	340.0 to 3800.0	ND to 13.3[d]	5,000	2,500	UCL concentration below PRG	No

[a]Wells used to establish a Base-specific range: SS01-W-10, SS01-W-17, SS01-W-26, SS01-W-27, LF01-W-12 (September 1993 sampling).
[b]NA - Not available.
[c]ND - Not detected.
[d]Analyte concentration is between instrument detection limit (IDL) and contract-required detection limit (CRDL).

Table A-3

Determination of Chemicals of Concern (COC) and Cleanup Levels in Soil
Southwest Drainage System (SD-09), OU-3
Williams Air Force Base

Chemicals of Potential Concern	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentrations (mg/kg)	PRG (mg/kg)	UCL Concentration[a] (mg/kg)	COC	Decision Basis
Organics						
Acetone	0.010 to 0.025	0.002 to 0.21	2,000	0.018	No	UCL concentration below PRG
Bis(2-ethylhexyl)phthalate	0.330 to 1.700	0.02 to 18	32	3.6	No	UCL concentration below PRG
Di-n-butyl phthalate	0.33 to 1.7	0.02 to 0.4	6,500	0.25	No	UCL concentration below PRG
Diethyl phthalate	0.33 to 1.7	0.019 to 0.41	52,000	0.25	No	UCL concentration below PRG
Ethyl alcohol	0.05 to 0.05	0.051 to 0.11	NL[b]	0.036	No	Low UCL. No PRG available
Methylene chloride	0.005 to 0.013	0.007 to 0.13	11	0.016	No	UCL concentration below PRG
Phenol	0.33 to 1.7	0.22 to 1.1	39,000	0.29	No	UCL concentration below PRG
Pyrene	0.33 to 1.7	0.024 to 0.41	2,000	0.27	No	UCL concentration below PRG
Toluene	0.005 to 0.013	0.001 to 0.012	1,900	0.004	No	UCL concentration below PRG
1,1,1-Trichloroethane	0.005 to 0.013	0.002 to 0.012	3,200	0.004	No	UCL concentration below PRG
Inorganics						
Antimony	12 to 20	8.5 to 68	31	22	No	UCL concentration below PRG
Arsenic	2 to 5	0.46 to 5.7	4.3	2.4	No	UCL concentration below PRG
Beryllium	1 to 3	0.47 to 2.2	1.6	0.90	No	UCL concentration below PRG
Cadmium	0.2 to 3	0.6 to 90	38	5.1	No	UCL concentration below PRG

Table A-3

Determination of Chemicals of Concern (COC) and Cleanup Levels in Soil
Southwest Drainage System (SD-09), OU-3
Williams Air Force Base

Chemicals of Potential Concern	Value or Range of Detection Limits (mg/kg)	Value or Range of Detected Concentrations (mg/kg)	PRG (mg/kg)	UCL Concentration[a] (mg/kg)	COC	Decision Basis
Chromium	2 to 5	12 to 53	210	33	No	UCL concentration below PRG
Copper	0.4 to 6	0.4 to 61	2,800	24	No	UCL concentration below PRG
Lead	0.6 to 2	8 to 96	400	32	No	UCL concentration below PRG
Mercury	0.2 to 0.4	0.17 to 0.19	23	0.11	No	UCL concentration below PRG
Nickel	8 to 8	9 to 31.5	1,500	20	No	UCL concentration below PRG
Selenium	1 to 3	0.47 to 0.58	380	0.64	No	UCL concentration below PRG
Silver	2 to 5	1.1 to 13	380	1.8	No	UCL concentration below PRG
Thallium	2 to 30	0.44 to 0.95	4.9	2.8	No	UCL concentration below PRG
Zinc	4 to 4	28 to 278	23,000	93	No	UCL concentration below PRG

[a]UCL concentrations calculated from combination surface and subsurface soils.
[b]NL = Not listed.

Table A-4

Summary of Remedial Action Objectives, OU-3
Williams Air Force Base

Site	Remedial Action Objective
FT-02	<u>Soil</u> Protect human health and the environment by reducing the concentration of benzene, chloroform, and 1,4-dichlorobenzene in FT-02 soils to 1.4, 0.53, and 7.4 milligrams per kilogram (mg/kg), respectively. The residual total ILCR for all chemicals in soil summed across all exposure pathways will be within the acceptable risk range of 10^{-6} to 10^{-4}. The reduction in organic contaminants will prevent the potential future migration of contaminants to groundwater. <u>Groundwater</u> No RAOs were developed for groundwater because the UCL concentration of all COPCs are below PRGs.
SD-09	<u>Soil</u> No RAOs were developed for the soil because the UCL concentrations of all COPCs are below PRGs. <u>Groundwater</u> There is no indication of groundwater contamination at SD-09; therefore, no RAOs were developed.

APPENDIX B

COST TABLES FOR FIRE PROTECTION TRAINING AREA NO. 2 (FT-02) REMEDIAL ALTERNATIVES

TABLE B-1. NO ACTION FOR FT-02 SOILS
Annual Operation and Maintenance Costs

Williams AFB
Project-409877.010
KT - S8 - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Monitoring labor (for groundwater sampling, 1 sample at Western Pit, 3 samples at Eastern Pit,	50	hour (hr)	32	hr per year	1,600
2. Purchased services					
Groundwater Monitoring (VOC) 1 sampling event per year, 1 sample at Western Pit, 3 samples at Eastern Pit,	600	sample	4	samples/event	2,400
3. Data evaluation/reporting	100	hr	32	hr/year	3,200
TOTAL OPERATING COST					7,200
1. Insurance, permits, taxes	4% operating				300
2. Rehabilitation costs					NA
3. Contingency	25% operating				1,800
4. Periodic site review (a)					28,000
TOTAL ANNUAL OPERATING COST (+50%, -30%)					37,300

a. Every 5 years, including groundwater modeling, cost shown is allocation for one year.
NA - not applicable

TABLE B-2. SVE FOR FT- 02 SOILS
Initial Capital Costs

Williams AFB
Project-409877.010
KT - S6FTSV - 03/29/95

COST COMPONENT	DESCRIPTION	COST ($)
DIRECT CAPITAL COSTS		
1. Site Preparation	3 acres	10,000
2. Extraction Wells	All wells are 4" diameter	
- Western Pit	1 well at 10 ft deep, 10 ft screen	2,000
- Eastern Pit	3 wells at 86 ft deep, and 5 wells at 43 ft deep, each has 43 ft screen	47,000
3. Demobilization of operating wells	After completion of the operation (9 wells)	8,000
4. Nested pieziometers (PZ)	2 piezometers at 86 ft, 1 PZ at 10 ft Extraction well nearby can be used also	15,000
5. Piping system and foundation (including surface sealing)	800 linear feet (4", 6 "and 10" diameter) (underground construction cost is included)	59,000
6. SVE Vacuum Skid-Mounted Systems	Including air/water separator & instrumentation	
- Western Pit: One 40 scfm blower	10" Hg vacuum, 5 Hp motor	22,000
- Eastern Pit: One 600 scfm blowers	18" Hg vacuum, 125 Hp motor	93,000
7. Condensate transfer system (collected in two 500 gal tanks on a trailer)	Condensate from air/water separator will be transported to the existing system	10,000
8. One Thermal Oxidation System with catalytic module (no heat exchanger)	Skid mounted system, rated for 1,000 scfm 3 million (MM) BTU/hour, 1,400 deg F	103,000
9. Electrical equipment	Including installation, wiring, and telemanager monitoring system	32,000
10. Shipping	8% of items 6 and item 8 (approx)	17,400
TOTAL DIRECT COSTS (TDC)		418,400
INDIRECT CAPITAL COSTS		
1. Engineering and related tech support	20 % TDC	83,700
2. SVE Pilot Test	Air permeability and pressure test (well installation is not included)	72,000
3. License, Permit, and Legal Fees	2 % TDC	8,400
4. Start-up (sampling costs are included)		65,000
5. Contingency	25 % TDC	104,600
TOTAL INSTALLED COST (+50%, -30%)		752,100

NA - not applicable

TABLE B-3. SVE FOR FT- 02 SOILS
Annual Operation and Maintenance Costs

Williams AFB
Project-409877.010
KT - S6FTSV - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Operating labor (a)	50	hour (hr)	8	hours per week	20,800
2. Monitoring labor	50	hour (hr)	8	hours per month	4,800
3. Maintenance					10,000
4. Materials					NA
5. Utilities					
. Electric Power					
2 Vacuum skids (125+5 Hp), gas fans, and water pumps.	0.08	Kwhr	2,775	Kwhr/day	81,000
. Fuel for fume incineration.	5.00	MM BTU	16.8	million BTU/day	30,700
6. Disposal					NA
7. Purchased services:					
a) Vapor samples analyses (b)	400	sample	4	samples/month	19,200
b) Water samples analyses	350	sample	2	samples/month	8,400
c) Soil Boring (b) (c)	15,000	sampling event	3	borings/2 years	7,500
d) Soil Monitoring (VOC) (d)	2,500	sampling event	1	sampling event per 2 years	1,250
8. Data evaluation	100	hr	40	hr/ 3 months	16,000
TOTAL OPERATING COST					199,650
1. Insurance, permits, taxes	4% operating				8,000
2. Rehabilitation costs					NA
3. Periodic site review (e)					NA
4. Contingency	25% operating				49,900
TOTAL ANNUAL OPERATING COST (+50%, -30%)					257,550

a. Operator is required to check system once per week (at 8 hours/trip)
b. Start-up sampling costs are not included.
c. 3 Borings with split spoon sampling.
d. Soil analysis includes a total of 5 samples.
e. Every 5 year; cost shown is allocation for one year.
NA - not applicable

TABLE B-4. BIOVENTING FOR FT- 02 SOILS

Initial Capital Costs

Williams AFB
Project-409877.010
KT - S7FTBIO - 03/29/95

COST COMPONENT	DESCRIPTION	COST ($)
DIRECT CAPITAL COSTS		
1. Site Preparation	3 acres	10,000
2. Extraction Wells	All wells are 4" diameter	
- Western Pit	1 wells at 10 ft deep, 10 ft screen	2,000
- Eastern Pit	3 wells at 86 ft deep, and 5 wells at 43 ft deep, each has 43 ft screen	47,000
3. Demobilization of operating wells	After completion of the operation (9 wells)	8,000
4. Nested pieziometers (PZ)	2 piezometers at 86 ft, 1 PZ at 10 ft Extraction well nearby can be used also	15,000
5. Piping system and foundation (surface sealing is not included)	800 linear feet (4", 6 "and 10" diameter) (underground construction cost is included)	49,000
6. Bio-Air Injection Skid-Mounted Systems - Combined Western Pit and Eastern Pit	One 200 scfm blower, 10 psig, 20 Hp motor	30,000
7. Condensate transfer system	Condensate from 1 air/water separator will be pumped to the existing system	NA
8. Electrical equipment	Including installation, wiring, and telemanager monitoring system	20,000
9. Shipping	Approximate	4,000
TOTAL DIRECT COSTS (TDC)		185,000
INDIRECT CAPITAL COSTS		
1. Engineering and related tech support		75,000
2. SVE Pilot Test	Air permeability and pressure test (well installation is not included)	72,000
3. Bioassessment, bio treatability test	Insitu pilot bio treatability test	175,000
4. License, Permit, and Legal Fees	2 % TDC	3,700
5. Start-up (sampling costs are included)		65,000
6. Contingency	25 % TDC	46,300
TOTAL INSTALLED COST (+50%, -30%)		622,000

NA - not applicable
NI - not included

TABLE B-5. BIOVENTING FOR FT- 02 SOILS
Annual Operation and Maintenance Costs

Williams AFB
Project-409877.010
KT - S7FTBIO - 03/29/95

COST COMPONENT	UNIT COST ($)	UNIT	QTY	UNITS/ PERIOD	ANNUAL COST ($)
1. Operating labor (a)	50	hour (hr)	8	hours per week	20,800
2. Monitoring labor	50	hour (hr)	8	hours per month	4,800
3. Maintenance					10,000
4. Materials					NA
5. Utilities					
. Electric Power					
1 Blower skid (20 Hp),	0.08	Kwhr	358	Kwhr/day	10,500
6. Disposal					NA
7. Purchased services:					
a) Vapor samples analyses (b)	400	sample	4	samples/month	19,200
b) Water samples analyses	350	sample	1	samples/month	4,200
c) Soil Boring (b) (c) 1 sampling event / 2 years	15,000	sampling event	3	borings/2 years	7,500
d) Soil Monitoring (VOC) (d)	2,500	sampling event	1	sampling event per 2 years	1,250
e) Soil Bio Monitoring (3 bores, 5 samples)	6,000	sampling event	1	sampling event per 2 years	3,000
8. Data evaluation	100	hr	40	hr/ 3 months	16,000
TOTAL OPERATING COST					97,250
1. Insurance, permits, taxes	4% operating				3,900
2. Rehabilitation costs					NA
3. Periodic site review (e)					NA
4. Contingency	25% operating				24,300
TOTAL ANNUAL OPERATING COST (+50%, -30%)					125,450

a. Operator is required to check system once per week (at 8 hours/trip)
b. Start-up sampling costs are not included.
c. 3 Borings with split spoon sampling.
d. Soil analysis includes a total of 5 samples.
e. Every 5 year; cost shown is allocation for one year.
NA - not applicable

APPENDIX C

LOCATION-SPECIFIC AND ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Table C-1

Chemical-Specific Applicable or Relevant and Appropriate Requirements
Fire Protection Training Area No. 2 (FT-02), OU-3
Williams Air Force Base

Chemical of Concern	UCL Concentration (mg/kg)	Cleanup Level (mg/kg)	Arizona HBGL[a] (mg/kg)	A[b]	RAR[c]
Benzene	7.3	1.4	47		FT02-4 FT02-5
Chloroform	0.66	0.53	220		FT02-4 FT02-5
1,4-Dichlorobenzene	8.2	7.4	57		FT02-4 FT02-5

[a]June 1996, Arizona Health Based Guidance Levels (HBGLs) were adopted by ADEQ on December 15, 1995, through emergency rule, as soil cleanup standards. These cleanup standards are undergoing final review prior to certification by the Arizona Attorney General. Once promulgated, the standards will become applicable or relevant and appropriate requirements (ARARs).
[b]Criteria is applicable for alternatives listed.
[c]Criteria is relevant and appropriate for alternatives listed.

Table C-2

Location-Specific Applicable or Relevant and Appropriate Requirements
Fire Protection Training Area No. 2 (FT-02), OU-3
Williams Air Force Base

Location	Requirement(s)	Prerequisite(s)	Citation	Comments	A[a]	RAR[b]
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archaeological data	National Archaeological and Historical Preservation Act (16 USC Section 469); 36 CFR Part 65			FT02-4 FT02-5

[a]Criteria is applicable for alternatives listed.
[b]Criteria is relevant and appropriate for alternatives listed:
Alternative FT02-1: No Action
Alternative FT02-4: Soil Vapor Extraction
Alternative FT02-5: Bioventing.

Table C-3

Action-Specific Applicable or Relevant and Appropriate Requirements
Fire Protection Training Area No. 2 (FT-02), OU-3
Williams Air Force Base

Action	Requirement(s)	Prerequisite(s)	Citation	Comments	A[a]	RAR[b]
Air Emissions Control During Remediation	Control of air emissions of volatile organics, particulates, and gaseous contaminants.	Emission of VOCs, particulates, and gaseous air contaminants	Maricopa County Air Quality Standards (Rules 200, 210, 220, 320) as dictated by the Clean Air Act		FT02-4 FT02-5	
Surface Water Control	Prevent run-on and control and collect runoff from a 24-hour 25-year storm (land treatment facility).	RCRA hazardous waste treated, stored, or disposed after the effective date of the requirements.	R18-8-264 referencing: 40 CFR 264.273 (c) (d)		FT02-4 FT02-5	
Container Storage (On Site)	Containers of hazardous waste must be: • Maintained in good condition • Compatible with hazardous waste to be stored • Closed during storage (except to add or remove waste). Inspect container storage areas weekly for deterioration. Place containers which contain free liquid on sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids or the volume of the largest container, whichever is greater.	RCRA hazardous waste (listed or characteristic) held for a temporary period before treatment, disposal, or storage elsewhere (40 CFR 264.10) in a container (i.e., any portable device in which a material is stored, transported, disposed of, or handled).	R18-8-264 referencing: 40 CFR 264.171 40 CFR 264.172 40 CFR 264.173 40 CFR 264.174 40 CFR 264.175	These requirements are applicable for any contaminated soil, groundwater, or treatment system waste that might be containerized and stored on site prior to treatment or final disposal. Groundwater or soil containing a listed waste must be managed as if it were a hazardous waste so long as it contains a constituent of the listed waste.	FT02-4 FT02-5	

Table C-3

Action-Specific Applicable or Relevant and Appropriate Requirements
Fire Protection Training Area No. 2 (FT-02), OU-3
Williams Air Force Base

Action	Requirement(s)	Prerequisite(s)	Citation	Comments	A[a]	RAR[b]
Container Storage (On Site) (Continued)	Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. Keep containers of ignitable or reactive waste at least 50 feet from the facility's property line. Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier. At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners. Storage of banned wastes must be in accordance with 40 CFR 268. When such storage occurs beyond 1 year, the owner/operator bears the burden of proving that such storage is solely for the purpose of accumulating sufficient quantities to allow for proper recovery, treatment, and disposal.		R18-8-264 referencing: 40 CFR 264.175 40 CFR 264.176 40 CFR 264.177 40 CFR 264.178 R18-8-268 referencing: 40 CFR 268.50		FT02-4 FT02-5	
Pretreatment for Discharge to POTW	Establish agreement with POTW with regards to pretreatment effluent discharge limits for treated water.	Discharge of treated water to POTW	40 CFR 403	Need to establish with POTW prior to discharge.	FT02-4	

[a]Criteria is applicable for alternatives listed.
[b]Criteria is relevant and appropriate for alternatives listed.
Alternative FT02-1: No Action
Alternative FT02-4: Soil Vapor Extraction
Alternative FT02-5: Bioventing.

GW-6. GROUNDWATER BIO TREATMENT COST ESTIMATE
HORIZONTAL WELLS WITH VAPOR-PHASE CARBON ADSORPTION
Capital Costs

Williams AFB
Project-409735.30.23.002
KT - wigbioh2 - 04/24/92

COST COMPONENT	DESCRIPTION	COST ($)
DIRECT CAPITAL COSTS		
1. Site Preparation	2.2 Acres	32,800
2. Extraction Wells	2 Recovery wells, 6" Id ss riser, 235 feet depth/well, 500 feet of 6" ss screen	1,700,000
3. Injection Wells	4 Injection wells, 4" Id ss casing, 200 feet depth/well, 100 feet of 4" ss screen	121,200
4. Extraction Well pumps	3 Extraction well pumps, including piping and controls	454,000
5. Monitoring Wells	3 Monitoring wells, 4.5" sch 80 pvc casing, 260 feet depth/well, 40 feet of 4" ss screen	90,900
6. Transfer Systems	Transfer pumps and storage tanks for untreated and treated water	283,100
7. Oil / water separator	Rated for 60 gallons / min.	13,000
8. Biotreatment system	60 gallon/minute system including reactor, clarifier and dewatering system	502,000
9. Vapor phase carbon adsorption	Skid mounted system, 3000 lbs carbon capacity	46,000
10. Treatability testing	Bench-scale biotreatment	65,000
11. Instrumentation	Central control and monitoring system	100,000
TOTAL DIRECT COST (TDC)		3,408,000
INDIRECT CAPITAL COSTS		
1. Engineering and Design	12 % TDC	408,960
2. License, permit, legal fees	2 % TDC	68,160
3. Start-up	5 % TDC	170,400
4. Contingency	15 % TDC	511,200
TOTAL INSTALLED COST (+50% , -30%)		4,566,720

GW-6. GROUNDWATER BIO TREATMENT COST ESTIMATE
HORIZONTAL WELLS WITH VAPOR-PHASE CARBON ADSORPTION
Annual Operating and Maintenance Costs

Williams AFB
Project-409735.30.23.002
KT - wigbioh2 - 04/24/92

	COST COMPONENT	UNIT COST ($)	UNIT	QUANTITY	UNITS/ PERIOD	COST ($/year)
1.	Operating labor	50	hour (hr)	80	hr/week	208,000
2.	Maintenance (1% TDC)					34,080
3.	Materials					
	Nutrient	0.2	pound (lb)	50	lb/day	3,650
	Carbon (a)	2.4	lb	60	lb/day	52,560
4.	Utilities					
	Electrical power	0.08	Kwhr	1537	Kwhr/day	44,880
5.	Disposal (biosludge) (b)	0.08	lb	450	lb/day	13,140
6.	Purchased services					
	Monitoring - Effluent	600	sample(s)	2	s /month	14,400
	- Wells (c)					74,900
	- Biological	300	sample(s)	3	s /week	46,800
7.	Administration					
	Data evaluation /reporting	70	hr	8	hr/week	29,120
	TOTAL					521,530
8.	Insurance, permits, taxes	4% operating				20,861
9.	Rehabilitation costs (d)					43,000
10.	Contingency	15% operating				78,230
11.	Periodic site review (e)					20,000
	TOTAL ANNUAL OPERATING COST (+50% , -30%)					683,621

a. Cost includes carbon purchase, shipping, and regeneration of spent carbon by supplier.
b. Cost for shipping recovered free phase hydrocarbons to reclaimer or Air Force user is considered covered by fuel value .
c. From groundwater, no action GW-1, and one additional monitoring well.
d. Replacement of well pumps every 4 years, and 10 years for other mechanical components.
e. Every 5 years ; cost shown is allocation for one year .